Engineering Library

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VOL. CXLVIII.—No. 3836] LONDON: FRIDAY EVENING, JULY 19, 1929 [PRICE { WITH INDEX AND OTHER SUPPLEMENT } 1s. 6d. BY INLAND POST 1s. 9d.

PUBLIC NOTICES

The Director-General, India Store Department, Belvedere-road, Lambeth, London, S.E. 1, invites TENDERS for :—
FORTY METRE GAUGE LOCO-MOTIVES.
Tenders due 13th August, 1929.
Forms of Tender available from the above at a fee of 5s. (which will not be returned). 2602

Crown Agents for the COLONIES.
COLONIAL GOVERNMENT APPOINTMENTS.
APPLICATIONS from qualified candidates are INVITED for the following POSTS :—

M/1579. ENGINEER (ARCHITECTURAL) REQUIRED by the GOVERNMENT of HONG KONG for the PUBLIC WORKS DEPARTMENT, for three years' service and possible permanency. Salary £460 a year, rising by annual increments of £20 to £500 a year, and thereafter, in the event of the appointment being made permanent, by further increments to a maximum of £1000 a year, payable in dollars under the Compensation Scheme at present in force at a favourable rate of exchange. Free first-class passages provided. Candidates, unmarried, 23 to 30 years of age, must be Associates of the R.I.B.A., and be conversant with all the usual routine of an Architectural Office, including the Preparation of Sketch Plans and Working Drawings, Specifications, Quantities, Measuring, &c., in connection with New Buildings, Additions and Alterations. Some knowledge of Steel and reinforced Concrete Design and Construction is also necessary.

M/1642. ASSISTANT ENGINEER REQUIRED by the GOVERNMENT of HONG KONG for the PUBLIC WORKS DEPARTMENT, for three years' service with possible permanency. Salary £460 a year rising by annual increments of £20 to £500 a year, and thereafter, if appointment is made permanent, by further increments to a maximum of £1000 a year, payable in dollars under the Compensation Scheme at present in force at a favourable rate of exchange. Conveyance allowance and an allowance for quarters if Government quarters are not available, in accordance with Government regulations. Free first-class passages. Candidates, unmarried, 24 to 30 years of age, must have passed Sections A and B of the A.M.I.C.E. Examination or hold qualifications accepted by the Institution as exempting from those examinations. Must be good Draughtsman, well up in Levelling, Land and Marine Surveying and Sounding. Must have had some experience in the Design and Construction of General Port Works.

M/1509. ASSISTANT ENGINEER REQUIRED by the GOVERNMENT of HONG KONG PUBLIC WORKS DEPARTMENT, for three years' service, with possible permanency. Salary £460, rising to £500 a year by annual increments of £20, and thereafter, if the appointment becomes permanent, rising by annual increments to a maximum of £1000 a year, payable in dollars under the Compensation Scheme at present in force at a favourable rate of exchange. Free first-class passages provided. Candidates, 22 to 26 years of age, single, must have passed Examinations for Sections "A" and "B" of the A.M.I.C.E. Diploma, or hold professional qualifications accepted by the Institution of Civil Engineers as exempting from those examinations. Must be able to carry out Surveys, make all the plans necessary for the Preparation of Detailed Design, and Prepare Bills of Quantities for the letting of work on contract in connection with Road Construction, including Bridge Work in Reinforced Concrete and the Construction of Buildings. Candidates must be able to ride a motor bicycle.

M/1503. ASSISTANT ENGINEER REQUIRED for the PUBLIC WORKS DEPARTMENT of the STRAITS SETTLEMENTS, for four years' service, after which, subject to satisfactory service, the officers appointed will be eligible for confirmation in the permanent and pensionable establishment. It is probable that the number of permanent appointments will be sufficient for those officers whose services have been entirely satisfactory, but no guarantee can be given. If at the end of four years' service an officer's services have been entirely satisfactory and he is not offered or declines further employment, he will be paid a bonus of 2850 dollars. Salary 400 dollars a month, rising to 800 dollars by annual increments of 25 dollars, plus a temporary non-pensionable allowance of 10 per cent. for bachelors and 20 per cent. for married men. The exchange value of the dollar in sterling is at present fixed by the Government at 2s. 4d., but its purchasing power in Malaya is considerably less than that of 2s. 4d. in the United Kingdom. No income tax at present imposed by the Straits Settlements Government. Free passages provided. Candidates, age 23 to 26, must have received a good theoretical training, preferably at a University or College recognised by the Institution of Civil Engineers, and possess a Civil Engineering Degree, or obtain such other Diploma or Distinction in Engineering as the Secretary of State may decide in any particular case, or have completed articles with a Civil Engineer of good standing, and have passed the Examination for Associate Membership of the Institution of Civil Engineers. In addition, candidates must have had at least one year's practical experience of Civil Engineering under a qualified civil engineer.

M/1637. ASSISTANT ENGINEER REQUIRED by the GOVERNMENT of TANGANYIKA TERRITORY for the RAILWAY DEPARTMENT, for a tour of 20 to 30 months' service, with possible extension. Salary £480, rising by annual increments of £20 to £600 a year and thence by annual increments of £30 to £720 a year. Outfit allowance of £30 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, 25 to 35 years of age, should have passed Sections A and B of the A.M.I.C.E. Examinations or hold Engineering qualifications accepted by the Institution as exempting from those examinations, or be Student Members of the Institution. Should have had experience of Railway Construction and Maintenance, and be well versed in the use of a Theodolite and Levelling Instruments; must be able to Design Bridges and Structural Steelwork.

Apply at once by letter, stating age, whether married or single, and full particulars of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting the reference number against the appointment for which application is made. 2590

Ministry of Transport.
ROADS DEPARTMENT.
APPLICATIONS are INVITED for a TEMPORARY APPOINTMENT as a JUNIOR CIVIL ENGINEERING DRAUGHTSMAN in the Roads Department of the Ministry of Transport at Whitehall at a commencing wage of £3 per week.
Applications should be made immediately in writing to the Establishment Officer, Ministry of Transport, 6, Whitehall-gardens, S.W. 1, stating age, qualifications, experience and references 2591

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PUBLIC NOTICES

Draughtsmen (Un- ESTABLISHED) WANTED for Commercial Motor Vehicles. One (first-class) experienced in Chassis Design; two (second-class), one experienced in Chassis details, one experienced in Body Work. Applicants must be British subjects and have served apprenticeship in Engineering Works. Salary (42-hour week), 1st Cl. Draughtsman, £175-£225 p.a.; 2nd Cl. Draughtsman, £150-£175 p.a., plus variable Bonus (giving a total at present of about £266-£330 and £233-£266 p.a. respectively).
Application forms, returnable by 3rd August, may be obtained from CHIEF SUPERINTENDENT of ORDNANCE FACTORIES, Royal Arsenal, Woolwich, S.E. 18. 2603

Bengal-Nagpur Railway Com- PANY, LIMITED.
The Directors are prepared to receive TENDERS for :—
460 STEEL ENGINE TYRES.
Specification and form of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, London, E.C. 2, on or after Monday, 15th July, 1929.
A fee of 10s. will be charged for each copy of the specification, which is NOT returnable.
Tenders must be submitted not later than NOON on Friday, 26th July, 1929.
The Directors do not bind themselves to accept the lowest or any Tender, and reserve to themselves the right of reducing or dividing the order.
By order of the Board,
R. C. VOLKERS,
2568 Secretary.

The Madras and Southern MAHRATTA RAILWAY COMPANY, LIMITED, invite TENDERS for :—
(1) 70 A.C. MOTORS and STARTERS for PERAMBUR WORKS REMODELLING, with SPARES for the Motors and Starters.
(2) 5510 HELICAL and VOLUTE SPRINGS.
Tenders are due in on Tuesday, 13th August, 1929, by 2 p.m.
Tender forms obtainable at Company's Office, fee ONE GUINEA each, which is not returnable.
The Directors do not bind themselves to accept the lowest of any Tender.
Company's Office :—
25, Buckingham Palace-road, Westminster, S.W. 1. 2592

PUBLIC NOTICES

NORTHERN INDIA
ENGINEERING DEVELOPMENT.
Many huge projects are completed, others are under construction, and still more are under consideration. When tendering, remember that we have handled, inter alia, all the material for the Lloyd Barrage, the largest irrigation scheme in the world, and that WE HAVE THE EXPERIENCE to enable us to quote you the most favourable terms for CLEARING and DESPATCHING up country any quantity of material to any site required.
For full particulars apply, EASTERN EXPRESS CO., Ltd., Karachi; or to Messrs. FORBES, FORBES, CAMPBELL and CO., Ltd. (Managing Agents), 9, King William-street, London, E.C. 4. P 5899

South Indian Railway Com- PANY, LIMITED.
The Directors are prepared to receive TENDERS for the SUPPLY of :—
1. LAMINATED SPRINGS.
2. BOLTS, NUTS, RIVETS, &c.
3. SPARE PARTS for LOCOMOTIVE ENGINES (Piston Valves, &c.)
Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.
Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked—"Tender for Laminated Springs," or as the case may be, with the name of the firm tendering, must be left with the undersigned not later than 12 Noon on Friday, the 2nd August, 1929.
The Directors do not bind themselves to accept the lowest or any Tender.
A charge, which will not be returned, will be made of £1 for each copy of Specification No. 1, of 10s. for each copy of Specification No. 2, and of 5s. for each copy of Specification No. 3.
Copies of the drawings may be obtained at the Offices of the Company's Consulting Engineers, Messrs. Robert White and Partners, 3, Victoria-street, Westminster, S.W. 1.
A. MUIRHEAD,
Managing Director.
91, Petty France,
Westminster, S.W. 1.
16th July, 1929. 2590

PUBLIC NOTICES

County Borough of Belfast.
TENDERS FOR THE SUPPLY OF MECHANICALLY PROPELLED VEHICLES, &c.
The Improvement Committee invite TENDERS for all or any of the following :—
Two 30 cwt. MOTOR LORRIES.
Two 2½ tons MOTOR LORRIES.
Two MOTOR SWEEPING MACHINES.
Two WATER TANKS, adapted for Use as Interchangeable Bodies on Refuse Collecting Vehicles.
Forms of Tender and particulars may be obtained at the Office of the City Surveyor, Mr. R. B. Donald, M. Inst. C.E.
Sealed Tenders on official forms only, accompanied by drawings and specifications of machines tendered, enclosed in envelope supplied with the Tender forms, endorsed with the name and address of the firm tendering, and marked "Tender for ——, Surveyor's Department," to be lodged or posted so as to arrive in my office not later than 1 p.m. on Saturday, the 3rd August 1929.
An Official Receipt must be obtained for every Tender delivered by hand. Tenders sent by post should be registered.
The lowest or any Tender will not necessarily be accepted.
R. MEYER,
2606 Town Clerk.

Clyde Navigation Trust.
DREDGING SUPERINTENDENT.
APPLICATIONS are INVITED for the VACANT POSITION of DREDGING SUPERINTENDENT, the duties attached to which include the supervision and working of the whole Dredging Plant engaged in the maintenance of docks and river. The person appointed must have had considerable experience in actual dredging operations, with a sound mechanical engineering training, able to deal with all matters affecting the maintenance and running of an extensive dredging plant. It is desirable that he should hold a First Class Marine Engineer's Board of Trade Certificate. He must be thoroughly capable of handling a large staff of men.
Replies, stating age, salary expected, and qualifications, to be addressed to the undersigned,
A. C. GARDNER, M. Inst. C.E., M.I. Mech. E., Engineer,
Clyde Navigation Trust,
16, Robertson-street, Glasgow, C. 2.
8th July, 1929. 2514

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED, ASSISTANT WORKS MANAGER for Locomotive Works. Applicants must state age, full particulars of qualifications and experience and salary required.—Address, 2586, The Engineer Office. 2589 A

WANTED, ENGINEER to MAKE SKETCHES, LAY-OUTS and ASSIST in SUPERINTENDENCE of INSTALLATION and ERECTION of MACHINERY in large factory near London. Send experience, salary required, age, and earliest can commence.—Address, P6016, The Engineer Office. P6016 A

WANTED IMMEDIATELY, ENGINEERS Experienced in Planning Package Handling Conveyor Systems. Must be high-grade men used to dealing with large internal transport problems.
Address, stating age, experience, present employment (if any), and salary required, P6004, The Engineer Office. P6004 A

WANTED, SHOP CLERK FOR WORKS MANAGER'S OFFICE. Typing, Collection of statistics, good at figures generally; some knowledge of charts for production purposes an advantage.—Write, stating experience, copies of references, salary desired, 2597, The Engineer Office. 2597 A

A PROMINENT MANUFACTURING CONCERN in the Midlands REQUIRE the SERVICES of a MAN capable of Designing Ingenious Units of Pressed Metal Work; experience of Camera, Gramophone, or Small Switch Work an asset.—Address, stating age, experience, and salary required, 2598, The Engineer Office. 2598 A

ASSISTANT ENGINEER REQUIRED to Works Engineer in large Woodworking Factory, London district. Must have had good primary and technical education and at least two years' subsequent practical experience. Some knowledge of Boiler Management, Steam Engines, D.C. and A.C. Electrical Plant essential. Knowledge of building construction and maintenance would be considered an added qualification.—Apply, with full particulars of age, education, experience, and salary required, to A.E., c/o Harris Lebus, Finsbury Works, Tottenham, N. 17. 2553 A

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SITUATIONS OPEN (continued)

ASSISTANT PLANT ENGINEER.—Young Capable man, age about 25, with up-to-date experience in Modern Production Methods and Maintenance of Plant, REQUIRED by Large Firm of Engineers in West London.—Write, stating full details of training and experience, age, salary, &c., to 2577, The Engineer Office. 2577 A

ENGINEER DESIGNERS WANTED for Conveyor Installations. Must be quick at preliminary lay-outs and have sound knowledge of light steel structure. Locality, South of England.—Write, stating age, experience, and salary required, Box 932, Sells Advertising Offices, Fleet-street, E.C. 4. 2558 A

ENGINEER SALESMAN REQUIRED to be attached to London office of leading Manufacturer of Internal Combustion Oil Engines.—Address in confidence, stating age, training, experience, salary required, and when free, 2521, The Engineer Office. 2521 A

ENGINEER WANTED for India, With Some Experience in Steam Production. Knowledge of commercial side an advantage. Under thirty, unmarried. Salary beginning £500. Free passages.—Write, giving full particulars and copies of refs. to 2580, The Engineer Office. 2580 A

ENGINEERING SALESMAN to Develop BUSINESS in Connection with Specialities Required for Steam and Hot Water Heating systems. State age, experience, salary.—Address, 2563, The Engineer Office. 2563 A

EXPERIENCED AIR COMPRESSOR and PNEUMATIC TOOL SALESMAN WANTED for London district by leading British manufacturers; must have present connection public works contractors and borough engineers.—Address, 2599, The Engineer Office. 2599 A

MECHANICAL ENGINEER, Having Some Electrical Experience, with University Degree, and capable of discussing proposals and quotations from both the technical and business aspects with London Consulting Engineers of the highest standing and with users. For a man who can fulfil these requirements and show results, there are prospects of advancement to a very remunerative life position. State fully education, training, experience, age (not over 40), and commencing salary.—Address, 2600, The Engineer Office. 2600 A

PRODUCTION MANAGER WANTED by Large Birmingham Firm. Must be experienced in Machine Shop practice, and capable of handling large staff of Departmental Foremen. The position will be under control of the Works Manager. Applications required only from live men accustomed to accurate machining, quick assembly, and high class quality of finished product. State age, qualifications, past and present employers, also salary required. Address, "PRODUCTION," Gibson and Ashford Waterloo-street, Birmingham. 2560 A

REQUIRED by an Important PUBLIC UTILITY COMPANY, a young qualified ENGINEER with mechanical experience and some knowledge of Hydro-electric Construction. State qualifications, experience, and salary required, Address, P5980, The Engineer Office. P5980 A

LANCASHIRE COMPANY REQUIRES SALESMAN for Marketing their Plant for Treating Boiler-feed Water; engineering training important. Will applicants state experience and salary required.—Address, 2564, The Engineer Office. 2564 A

REQUIRED, First-class ASSISTANT for Large Structural General Engineering and Ship Repairing Works out East. Applicants must have served full apprenticeship in engineering workshops, with subsequent technical training at Engineering College or University and have obtained B.Sc. or B.E. Degree. Good appearance and address essential; public school man preferred. Single, age 25 to 28. Must be well up in Structural Work, able to estimate and check all calculations.—Write in first instance, stating salary expected, to Z.Z. 710, c/o Deacon's Advertising Agency, Fenchurch-avenue, London. 2541 A

REQUIRED for Liverpool District, Fully Qualified ENGINEER, to Design Special Automatic Packing and Conveying Plant for Chemical Works. Previous experience in Chemical Engineering Design essential. Salary, £250, annual increments £15-£350, together with cost-of-living bonus (total present salary with current bonus, £361).—Write, "J. L., c.o. Charles Barker and Sons, Ltd., 31, Budge-row, E.C. 4. 2581 A

SALESMAN (YOUNG), with Workshop and Drawing-office experience, knowledge of Flour-milling Machinery an advantage. State age, experience and salary.—Address, P6020, The Engineer Office. P6020 A

YOUNG ENGINEER.—VACANCY OCCURS in London office of Export Engineers. Age 24 to 28. Export office experience essential, and knowledge of Oil Engines, Road-making and Agricultural Machinery desirable.—Address, 2569, The Engineer Office. 2569 A

WANTED, an Experienced All-round DRAUGHTSMAN, DESIGNER, and ESTIMATOR, with Shop experience, as principal Assistant to Chief Engineer of large General Engineering, Structural and Foundry Works. Applicants must give full particulars as to age, education and experience in Drawing Office and Shops. Salary, £700 per annum. Applications treated confidentially.—Address, 2575, The Engineer Office. 2575 A

WANTED, SENIOR DRAUGHTSMAN, with Machine Tool experience for Midlands. State full experience, age and salary required.—Address, 2604, The Engineer Office. 2604 A

DRAUGHTSMAN DESIGNER REQUIRED, Experienced in the design of Modern High-speed Machinery. A knowledge of Woodworking Machinery would be an added recommendation.—Apply, giving full particulars of age, education, experience, and salary required, to D.D., c/o Harris Lebus, Finsbury Works, Tottenham, N. 17. 2554 A

DRAUGHTSMAN, Good Technical Training, With experience in Motor Cycle and Car design; must be quick and accurate.—State age, experience, salary required, and when free, to ASCOT MOTOR and MANUFACTURING COMPANY, Letchworth, Herts. 2568 A

DRAUGHTSMAN.
JUNIOR ENGINEERING DRAUGHTSMAN REQUIRED temporarily for Railway Engineer's Office in London; experience in Permanent Way and Surveying essential.
Address, stating age, experience, and salary required, 2525, The Engineer Office. 2525 A

DRAUGHTSMAN (Junior) WANTED by Small N. London firm; must be keen and trustworthy man with good Works and D.O. exp. on mechanical work.—Address, stating exp., age, and sal. reqd., P6024, The Engineer Office. P6024 A

DRAUGHTSMAN (Junior) WANTED London. General mechanical engineering. Automobile experience an advantage.—Address, 2557, The Engineer Office. 2557 A

DRAUGHTSMAN. — MECHANICAL-ELECTRICAL, Experienced in Design of A.C. and D.C. Motors.—Address, giving particulars of experience, age, and salary required, to 2570, The Engineer Office. 2570 A

SITUATIONS OPEN (continued)

DRAUGHTSMAN, MECHANICAL. Experienced Steam Machinery preferred, Birmingham.—Address, P6008, The Engineer Office. P6008 A

DRAUGHTSMEN, Permanent, WANTED, Co. Durham. Must be thoroughly live and competent men. Accustomed Coal-handling Plant Apparatus, Elevators, Conveyors and Chute Development with economic Structural Design experience.—Address, stating experience, age, and wage expected, 2517, The Engineer Office. 2517 A

DRAUGHTSMEN REQUIRED, Experienced in Design of Elevators and Conveyors.—Write, stating age and salary required, X D, c/o J. W. Vickers and Co., Ld., 24, Austin Friars, E.C. 2. 2605 A

DRAUGHTSMAN REQUIRED for Leading Automobile Concern, Coventry district. Give fullest particulars, including experience, age, and salary required.—Address, 2570, The Engineer Office. 2570 A

DRAUGHTSMEN REQUIRED for Machine Tool design, Jigs and Fixtures, Tool Equipment.—Apply in writing, stating experience, age, salary, WEBSTER and BENNETT, Ltd., Coventry. 2476 A

DRAUGHTSMAN REQUIRED TEMPORARILY for Westminster Office; must be good tracer.—Write, stating age, experience, and salary required, and enclosing sample of work, which will be returned, to P6019, The Engineer Office. P6019 A

DRAUGHTSMAN, Senior, with First-class Experience of Steam Turbine design and details.—Apply, stating age, experience, and salary required, to MANAGER, Drawing-offices, B.T.H. Co., Ltd., Rugby. 2571 A

DRAUGHTSMAN, with Experience of Power Transformers.—Apply, stating age, experience, and salary required, to MANAGER, Drawing-offices, B.T.H. Co., Ltd., Rugby. 2508 A

DRAUGHTSMAN, 25 to 30, WANTED. One Used to Machine Arrangements and Shop Details preferred. State experience and salary required.—Address, 2595, The Engineer Office. 2595 A

ELECTRICAL or MECHANICAL DRAUGHTSMEN REQUIRED by large Firm of Engineers in the Lancashire area. Summer holidays considered.—Address, with details of age, experience, and salary required, 2414, The Engineer Office. 2414 A

ENGINEER (DRAUGHTSMAN), Accustomed to designing Reciprocating Deep Well Pumping Machinery, Estimating, &c. Good prospects for suitable applicant.—Address, stating age, experience, and salary required, 2493, The Engineer Office. 2493 A

ENGINEERING TRACER, Young Man or Experienced youth, REQUIRED for London Office. State salary required.—Address, 2601, The Engineer Office. 2601 A

INDIA.—REQUIRED by British Firm of Engineers, DRAUGHTSMAN accustomed to Roof, Bridge, and Structural Steel Work; able to Work Out Stresses and Prepare Designs, Estimates, and Detail Drawings; must be a bachelor, age 22 to 25.—Apply, stating age and particulars of experience, to Z.Y. 752, c.o. Deacon's Advertising Offices, Fenchurch-avenue, London, E.C. 3. 2503 A

JIG and TOOL DRAUGHTSMAN, Accustomed to designing fixtures for Automobile components. Must be quick and accurate.—State age, experience, salary required, and when free, to ASCOT MOTOR and MANUFACTURING COMPANY, Letchworth, Herts. 2569 A

LOCOMOTIVE DRAUGHTSMAN.—REQUIRED, the SERVICES of a LOCOMOTIVE DRAUGHTSMAN by Firm in Westminster; applicants must have had practical experience in a Locomotive Shop and Drawing-office, and should be specially conversant with the Design of Cylinders and Valve Gear; age not over 30.—Address, 2594, The Engineer Office. 2594 A

MECHANICAL ENGINEERING DRAUGHTSMAN REQUIRED, age about 20-27 years, for London Rolling Shutter Manufacturers.—Address, P6012, The Engineer Office. P6012 A

PLANT ENGINEERING DRAUGHTSMAN REQUIRED; good experience of Factory Building Design.—Apply, stating age, training, experience, and salary required, to the EMPLOYMENT SUPERINTENDENT, The Avon India Rubber Co., Ltd., Melksham, Wilts. 2562 A

THE CHATWOOD SAFE CO., Ltd., Bankers' Engineers, Shrewsbury, find it necessary to increase their Drawing-office Staff, and INVITE APPLICATIONS from MEN who have had a sound mechanical engineering training.
State experience, age, and salary required, addressed to the TECHNICAL DIRECTOR. 2503 A

TOOL DRAUGHTSMAN REQUIRED. Must be first-class man, accustomed to Designing Lay-outs for Semi and Full Automatic Turret Chucking Lathes.—Reply, stating age, experience, and salary expected, "DRAUGHTSMAN," c.o. Dixon's, 195, Oxford-street, London, W. 1. P6021 A

TWO DRAUGHTSMEN REQUIRED for Precision Grinders, Radial and other Drilling Machines. Preference given to applicants previously engaged on Machine Tools, but other useful experience considered. State qualifications, age and salary required.—JONES-SHIPMAN, Machine Tool Manufacturers, Leicester. 2574 A

WANTED, ENGINEERING-SHOP FOREMAN for Light Steel Framing and simple machine parts, must be able to select and control high grade mechanics, have thorough knowledge of speed production and organisation of work in hand.—Address, stating age, experience and salary required, to P6005, The Engineer Office. P6005 A

SITUATIONS OPEN (continued)

FOREMAN PLATER, Experienced, Accustomed to all kinds of Pressure Work, Transformer Tanks, Chemical Plant, &c. Must be used to modern shop practice and piece work rates. S.E. London.—Write, stating age, experience and salary, in strict confidence, Box 928, Sells Advertising Offices, Fleet-street, E.C. 4 2559 A

SITUATIONS WANTED

CHIEF ENGINEER, with Extensive Experience in layout and details of iron and steel works, coal washery and coking, ropeways, locomotives, cranes, buildings, steel constructional work, surveying and levelling, boilers, and hydraulics, is OPEN for immediate ENGAGEMENT.—Address, P5963, The Engineer Office. P5963 B

DETAIL and DESIGN DRAUGHTSMAN, Experience in railway rolling stock, omnibuses, aircraft machines, cranes, structural and general engineering; age 37. Technical and works experience.—Address, P5996, The Engineer Office. P5996 B

ENGINEER, A.M.I. Mech. E., Capable Organiser, first-class experience in design and manufacture of process plant for chemical industries, factory layout and reorganisation of plant and machinery, SEEKS FRESH APPOINTMENT. Excellent references; at present disengaged.—Address, P6015, The Engineer Office. P6015 B

ENGINEER, Mechanical and Electrical, Expert designer, organiser, estimator, unique commercial experience; moderate salary for PROGRESSIVE POST; age 40, at liberty.—Address, P6013, The Engineer Office. P6013 B

ENGINEER (36) DESIRES PROGRESSIVE POST. Excell. exper. elec., gen., D.C., A.C., steam, gen. and fuel technology, chemistry, general machinery, constr. and mainten. work; sound theor. training—Address, P6023, The Engineer Office. P6023 B

FOUNDRY MANAGER DESIRES POST; 14 Years' practical experience in loam, green and dry sand, 16 years of management; capable organiser, excellent references; disengaged 21st inst.—Address, P6022, The Engineer Office. P6022 B

FOUNDRY MANAGER DESIRES CHANGE; foundry apprentice and university trained, accustomed to modern plant and practice, electric furnace, &c., steel, iron and malleable, machine shop and erecting experience; tall, young, and ambitious.—Address, P6018, The Engineer Office. P6018 B

JIG, TOOL, PRESSWORK and AUTOMATIC LAY-OUT WORKS and D.O. EXPERIENCE of young man (31) is OFFERED for moderate salary in position of responsibility in works, D.O., or representation. Advertiser has good knowledge of French and German and has passed London Inter. B.Sc. (Eng.).
Address, P5984, The Engineer Office. P5984 B

MACHINE SHOP.—POSITION REQUIRED as SUPERINTENDENT or ASSISTANT (according to size of works). First-class general engineering experience, with specialised knowledge of capstan and auto. turning; progressive position will be considered.—Address, P6007, The Engineer Office. P6007 B

MECHANICAL ENGINEER, B.Sc. 28, 10 Years technical and commercial experience, steam raising and prime movers, SEEKS responsible POST.—Address, P5974, The Engineer Office. P5974 B

PRACTICAL COMMERCIAL ENGINEER DESIRES POST as MANAGER or responsible position. Wide experience, management general engineering and foundry. Excellent references.—Address, P5924, The Engineer Office. P5924 B

WITHOUT PAY.—INDIAN STUDENT, 1st Class B.A., B.Eng. (Sheffield University), wishes to obtain PRACTICAL TRAINING and EXPERIENCE with Reinforced Concrete Engineers. Remuneration expected only when worth has been proved.—Address, P6011, The Engineer Office. P6011 B

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A Seven-Day Journal

Charing Cross Bridge.

ON Tuesday, at the weekly meeting of the London County Council, Sir Percy Simmons, Chairman of the Improvements Committee, announced that heads of agreements on the Charing Cross Bridge scheme had now been reached between himself, the Ministry of Transport, and representatives of the Southern Railway. The agreement reached is subject to the approval of the London County Council as a whole and of the Improvements Committee. It is also subject to the approval of the proprietors of the railway company, of whom a meeting is to be called for July 30th. If both parties express their approval, parliamentary powers to cover the whole of the Charing Cross Bridge scheme will, it is hoped, be applied for in the autumn. Up to the moment of writing, details of the provisional agreement have not been published.

A New Harwich-Hook Steamer.

AT the beginning of this week the new cross-Channel steamer "Vienna," recently constructed by John Brown and Co., Ltd., of Clydebank, Glasgow, for the Harwich–Hook of Holland service of the London and North-Eastern Railway, made her maiden voyage. The new steamer is one of three new vessels for this route, and the other steamers, the "Amsterdam" and "Prague," will be commissioned early next year. In regard to size, the "Vienna" is considerably larger than the previous steamers employed on the Harwich–Hook service, and she is reported to be one of the largest and most luxurious cross-Channel steamers in the British Isles. Her overall length is 366ft., with a beam of 50ft., and a depth to shelter deck of 27ft. She has a loaded draught of 15ft 3in., and a gross tonnage of 4218. The propelling machinery comprises a twin-screw arrangement of Brown-Curtis compound turbines, driving the propeller through single reduction gearing. The designed shaft horse-power is about 9681, and the sea speed under normal conditions will be 21 knots. The boilers are of the single-ended cylindrical type, working under forced draught with coal firing, and are designed for a working pressure of 215 lb. per square inch. There are three turbo-generator sets, which supply current for lighting and power services. All the deck auxiliary machinery and most of the engine-room auxiliary machinery is electrically operated, and we understand that special attention has been given to the silent working of all the machinery. Sleeping accommodation for 450 first-class and 104 second-class passengers has been provided, along with several large public rooms, and a restaurant. Special facilities for the carriage of cargo and mails are provided, and the total stowage capacity for this purpose is over 40,000 cubic feet. The navigation and safety equipment includes all the latest devices for the safety of the ship and includes submarine signalling and "Echo" sounding machines.

Navigation in Fog.

AN invention which, it is claimed, will prove of considerable value for the navigation of ships in fog has recently been tested on the Great Western Railway Company's cross-Channel steamer "St. Julien," operating on the company's service between Weymouth and the Channel Islands. The trials have taken place over a period of three weeks, and they ended on Monday last, July 15th. The device, which has been invented by a Birmingham engineer, is styled the H.J.B. fog navigating compass and sound indicating unit. It picks up by means of an instrument, rather similar to a wireless receiving set, all sounds within a considerable area, indicating both the position and nature of the different signals. The instrument is said to be remarkably sensitive, and sounds which are quite inaudible to the ear are stated to be readily picked up and recorded. The value of such a device for the navigation of a ship in fog may be readily imagined; and if the recent tests establish the claims made for the new device there is every possibility of its soon becoming as definite a part of a steamer's navigating equipment as the compass. Other applications of the same instrument include aerial navigation, the location of distant gunfire, and the recording of the approach of aircraft, while, in a modified form, the device may be used for depth sounding and the fixing of the position of submerged objects. During the trials recently carried out on the "St. Julien," the inventor was assisted by other engineers and members of the ship's wireless staff.

French Railway Speeds.

A SUMMARY of the railway speeds in France, compiled by *La Journée Industrielle*, shows that there has been a notable acceleration on a large number of routes, and that there are now sixty-eight trains on all the systems, except one, that travel at average speeds exceeding 56 miles an hour. Alike in non-stop runs and average speeds, the French performances are only surpassed by those in Great Britain. The fastest train is that between Paris and St. Quentin, which covers the distance of 95 miles in 92 minutes. The Midi comes next with the electrified Sud Express between Bordeaux and Dax, the distance of 91¼ miles being covered in 89 minutes. The Nord has the largest number of fast trains, and the new Paris–Berlin train completes the distance of 133·9 miles between Paris and Aulnoye at an average speed of a shade less than 60 miles an hour. Another Pullman train, called the "Blue Bird," makes a non-stop journey from Brussels to Paris, a distance of 194 miles, in 3 h. 30 min., the speed on the Belgian lines being appreciably lower than in France. The average speed of the "Golden Arrow," between Paris and the Calais Maritime Station, is 58¼ miles an hour, but here, again, there is a considerable slowing down for part of the journey, namely, between the town and harbour stations. Great improvements have also been made on the Est railway system, where, despite gradients and frequent slowing down, good averages are maintained. Between Nancy and Paris three trains accomplish the journey of 218 miles at an average speed of 55¼ miles an hour. Over the 156 miles between Paris and Bar-le-Duc the average speed is 57½ miles an hour. The fastest train on the State Railways is that which travels between Paris and Rouen, a distance of 38·8 miles in 41 minutes.

The R.A.F. Display.

THE annual display of the Royal Air Force at Hendon is undoubtedly growing in popularity. Last Saturday one hundred thousand people, it is estimated, entered the aerodrome, while probably almost as many more witnessed the flying from points of vantage outside the grounds. It appeared to us that the public not only attended in larger numbers, but showed an increased knowledge and appreciation of the machines and their handling. If behind the charitable objects which benefit from the display, behind the gigantic mobilisation test which it provides for all ranks of the Air Force, the display has a third object, the encouragement of what has come to be known as "air-mindedness" in the civil population, then the Display Committee and the Ministry may rest assured that that object is being achieved. It was patent, too, that the skill and daring of the Air Force's pilots are being maintained at the level established during the war, a standard of comparison which is never likely to become obsolete, and that year by year the improvement of the flying equipment which is provided for them by the joint efforts of the Ministry and the aircraft industry is enabling that skill and daring to be applied in new directions. Aerobatics, parachute descents, balloon chasing, and the picking up of messages from the ground demand a combination of courage, nice judgment, and efficient equipment. But to those with a knowledge of aeronautics, and there were obviously many such at Hendon last Saturday, the simultaneous taking off of twenty-seven Siskin-Jaguar single-seater fighters showed that even since last year great progress has been made in the handling of machines, and in the unseen organisation in the background required before they can take to the air. Probably less noticed by the public, but equally striking as a sign of development, was the demonstration of the manœuvrability of the modern bomber, given by the Sidestrand-Jupiter when attacked by two Siskins. Not so long ago the manœuvres performed by this twin-engined machine would have been regarded as the exclusive function of light specially designed fighters.

Photographs and Pictures by Telegraph.

SOME months ago we referred in this column to the experimental work which had been done by the General Post Office on the transmission of telegrams in facsimile. A few days ago the Postmaster-General made a further statement regarding the experimental transmission of photographs, pictures, and similar matter by telegraphy. After consultation with the German Postal Administration, it has been decided to establish a public service for the transmission of pictures by telegraph between London and Berlin. The necessary apparatus has been ordered, and it is hoped that the new service will be in operation within the next two or three months. The rates to be charged and the conditions of service are matters which are at present under discussion by the British postal authorities and the German administration. At first the new service will be of an experimental character, and the question of its permanent adoption and its possible extension to other routes will, it is understood, be considered in the light of the experience which will be gained.

The Belfast Shipyard Joiners' Dispute.

LAST week an official announcement was made concerning the admission to the membership of the Shipbuilding Employers' Federation of the two Belfast firms of Harland and Wolff, Ltd., and Workman, Clark and Co. (1928), Ltd., along with Cox and Co., Ltd., of Falmouth. Harland and Wolff, Ltd., have been, for several years, members of the Federation in respect of their yards and repair shops on the Clyde, Mersey, Thames, and at Southampton, and the inclusion of their Belfast yards along with those of Workman, Clark and Co., now makes the Shipbuilding Employers' Federation fully representative of the shipbuilding and ship-repairing industries both in Great Britain and Ireland. At an adjourned meeting of representatives of the Belfast Shipbuilding Companies and the Amalgamated Society of Woodworkers—whose members have been on strike in Belfast during the past three months—held in Belfast on Tuesday, July 16th, it was stated by the employers that such matters as the present claim relating to wages, which was a question of general importance to the industry, would be dealt with by the Federation on a national basis. The men's representatives expressed their disappointment that the employers were not in a position to make any offer with regard to the original wages claim, and they undertook to report the course of the negotiations to a meeting of the men. The Conference was terminated after a further full discussion of the whole position had taken place.

An Electric Train Service to Altrincham.

IN a Journal note of April 19th we recorded the principal particulars of the scheme for the conversion of the Manchester–Altrincham line from steam to electric operation on the 1500-volt direct-current system. Within the last few days contracts have been let for the sub-stations, and the overhead and rolling stock equipments. The rotary converters and the other necessary electrical equipment for the two sub-stations at Cornbrook and Timperley are to be supplied by the British Thomson-Houston Company, Ltd., while the overhead equipment will be made by Callender's Cable and Construction Company, Ltd. The General Electric Company, Ltd., is to manufacture the electrical equipment for the rolling stock. The three contracts referred to above amount in all to about £200,000, and it is anticipated that almost the same sum of money will be spent on the rolling stock, the actual construction of the sub-stations, and their high-tension wiring. The supply of current will be taken from the Stretford District Electricity Board's system at a pressure of 11,000 volts, and will be delivered to the railway system at 1500 volts. The rolling stock will consist of six-car trains of the compartment type, each with a seating capacity of 536 passengers, each six-car train being divided into two three-car units. The work which has now been begun should be finished in about twelve to eighteen months' time.

Proposed New Atlantic Liners.

ACCORDING to Mr. Sheedy, the Vice-President and general manager of the United States Lines, it has now been decided that the company will early in 1930 place orders for the construction of two superliners for Atlantic service. The price of each ship has been mentioned as five million pounds, but that price would seem to take into account the high building costs at present ruling in United States shipyards. It is stated that the length of the new ships will be about 956ft., and that they will be designed to carry 4000 passengers. The projected displacement has been given as about 56,000 tons, and the means of propulsion to be adopted is stated to be either quadruple screw turbo-electric or geared turbine drive. No indication of the power to be developed has been given, but it is stated that the proposed ships will be the fastest afloat. In Italy new construction of large liners for the North and South Atlantic services is to be begun. Two ships, each of over 40,000 tons, are to be built as soon as possible in Italian yards, to the orders of the Lloyd Sabaudo Company and the Navigazione Generale Italiana. The new liner for the last named company is to be built in one of the Ligurian shipyards, and will be named the "Guglielmo Marconi," while the Lloyd Sabaudo ship will take the name of the "Conte Azurro," and will be built by the Stabilimento Tecnico Triestino Company. The length of the new liner is to be over 800ft., with a gross tonnage of 42,000 to 45,000, and a designed speed of 27 to 28 knots, with a service speed of 25 knots. Meanwhile on Tuesday evening last, the 16th inst., the new North German Lloyd liner, "Bremen," left Bremerhaven on her maiden voyage for New York. In the course of her trials the "Bremen" is reported to have attained a speed of over 28 knots, but her owners state that they have no intention of attempting to beat records on the first voyage.

London's Traffic Problems.

IN the House of Commons on Wednesday evening last the Co-ordination of Passenger Traffic Bill of the London County Council was rejected by a majority of 123 votes on the order for the third reading, and the associated measure of the London Electric Railway Companies was negatived without a division taking place. The London County Council Bill was introduced by Sir Kingsley Wood, who outlined the proposed solution of a co-ordinated scheme of public and private services. The Minister of Transport, Mr. H. Morrison, agreed with all that was said with regard to the urgency of the problem of London's traffic, but said that the Bill did not raise so much the question of congestion of traffic as rather the question of its development as an economic system. The Government could not advise the House to pass these Bills, but they would immediately consider the problem, and he (the Minister) would confer with the London County Council and the Advisory Committee. The door was still open, he said, for further consultations.

Transformer Tap-Changing on Load.

No. II.*

WHERE the energy of the main circuit is transformed at a point suitable for regulation, the necessary tapped winding can form part of the main transformer itself; in other cases special regulating boosters are necessary. The latter may consist of a single transformer with the necessary switchgear, or separate regulating and boosting transformers, the former giving a variable voltage supply to the primary of the latter. The switches for the single transformer method must be insulated for line voltage and capable of

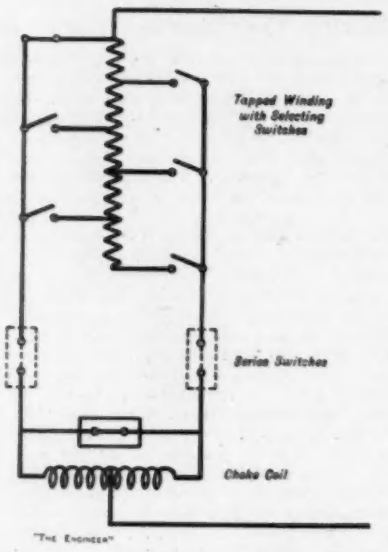


FIG. 16—SINGLE TAP METHOD

carrying line current; whereas the kVA of the intermediate circuit between regulating and boosting transformers is only the kVA of the boost required, and the voltage and current may be jointly adjusted to give minimum switchgear cost. Whether the tapped winding is part of the main transformer itself or of a separate regulating transformer, the same problems arise. In changing from one tap to the next the circuit must never be completely broken nor must it be possible to short-circuit the winding between the tappings. During the change means must be provided of limiting the current between tappings. For this purpose reactance is considered to be better than resistance, since the latter absorbs energy. The reactance may be either a separate choke coil introduced for the purpose or it may be inherent in the arrangement of windings used. Alternatively a special form of induction regulator may be used, as described in the previous article. Owing to eddy current loss the cross section of conductor which may be used in a transformer winding is strictly limited and the use of parallel conductors soon becomes necessary. It is a comparatively simple matter to arrange these parallel circuits with any desired reactance between them with no detriment whatever to the transformer, thus obtaining the reactance necessary for tap-changing purposes without any appreciable increase in cost.

Apart from the two methods of using reactance there are two classes of circuit disposition with contrasted arrangements of switchgear, viz., (A) single tap circuits, and (B) duplicate tap circuits. The use of a separate reactance is essential with (A) but not with (B)—in other words, the scheme (B) may be used with either separate or inherent reactance. Fig. 16 shows a typical arrangement of single tap switching and Figs. 17 and 18 duplicate tap switching. There are, of

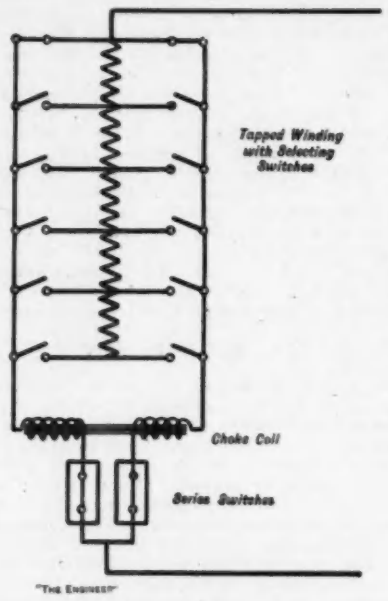


FIG. 17—DUPLICATE TAP METHOD WITH SEPARATE RESISTANCE

course, many possible circuit modifications, but they all fall into one or other of the above classes. If the choke coil is suitably designed it can be used as an auto transformer giving an intermediate position between tappings, thus allowing the number of tappings to be approximately halved. In any of these arrangements, if the selecting switches are made capable of breaking load current, the series switches shown may be omitted, but it is only in the case of arrangements similar to Fig. 16 in which the number of selecting switches is a minimum that any saving is likely to result from such a course. Every switch which has to break current must be easily accessible for the maintenance of contacts and renewal of switch oil. If, therefore, the series switches are dispensed with, it is necessary for all tapped connections to be brought out of the transformer tank, but this is undesirable in the case of high-voltage tappings.

Ferranti, Ltd., the gear of which we now propose to consider, only omit the series switches when the tappings are at a sufficiently low potential to allow of their being brought out to contactor gear safely and at a reasonable cost. Where these conditions do not obtain and where parallel circuits in the windings would not otherwise be desirable and their introduction would cost more than the provision of a separate reactance, the firm uses arrangements similar to that shown in Fig. 17. Where series switches are employed the tap-selecting switches can be inside the transformer close to the tapped coils, so that not only have the minimum number of connections to be brought out of the tank, but the tapping connections themselves are of minimum length so that expensive cleating can be avoided. Except in a few special cases the tap-selecting switch used for on-load tap changing is identical with the firm's well-known "off-load" switch.

In the operation of selective switchgear the inertia of the moving parts makes it difficult to obtain rapid completion of one definite cycle coupled with the avoidance of over-shoot. In the Ferranti gear this is overcome by the introduction of a simple form of intermittent gearing which leaves the motor free during the starting and stopping period without introducing shock when it commences to drive the mechanism. Assuming that 50 revolutions of the motor are required to complete the cycle, the motor is arranged to run for 100 revolutions per cycle; that is, 25 revolutions in which to accelerate, 50 to operate the gear, and 25 in which to stop. Careful adjustment and maintenance of the electro-magnetic

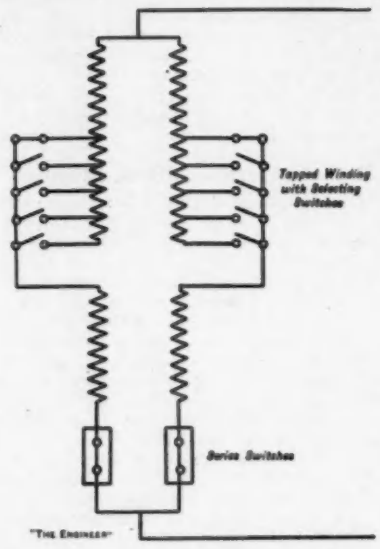


FIG. 18—DUPLICATE TAP METHOD WITH INHERENT RESISTANCE

brake is therefore unnecessary. The mechanical gear, which comprises positive-action cams and intermittent gearing to operate the switches in the correct sequence, is contained in a weatherproof casing, mounted on the cover of the transformer tank, the cover, together with the transformer, being capable of being lifted as one unit. Access to the interior of all portions of the mechanism is provided by removable covers, and the whole of the gear runs in oil baths and can be made suitable for outdoor operation. Ferranti regulating equipments can be controlled automatically or by hand, and, in the latter case, either direct or by remote electrical control may be employed. Where the control is automatic, time-lag relays are generally introduced to prevent the regulator attempting to correct transient voltage fluctuations. If the regulator is electrically controlled from a remote point the control switch is of the hand-operated rotary type, having a contact corresponding to each tapping position.

If the control switch is moved to a new position the control relay immediately causes the tap changer to follow the control switch to the new position, and the arrangement is said to give a much more positive control than the usual arrangement of push buttons. The simultaneous operation of the tap-changing equipments on parallel banks of transformers can be ensured by the use of a common control switch, but to allow of individual operation coupling switches are also provided on the control panel to enable the

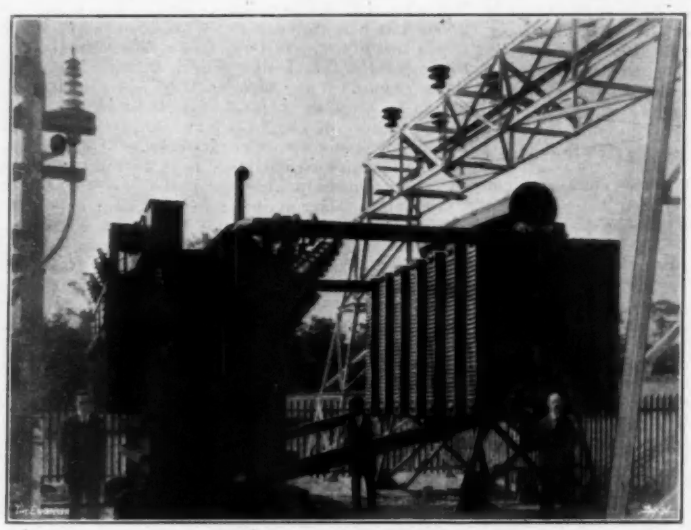


FIG. 19—7500-kVA 3-PHASE TAP-CHANGING TRANSFORMER—FERRANTI

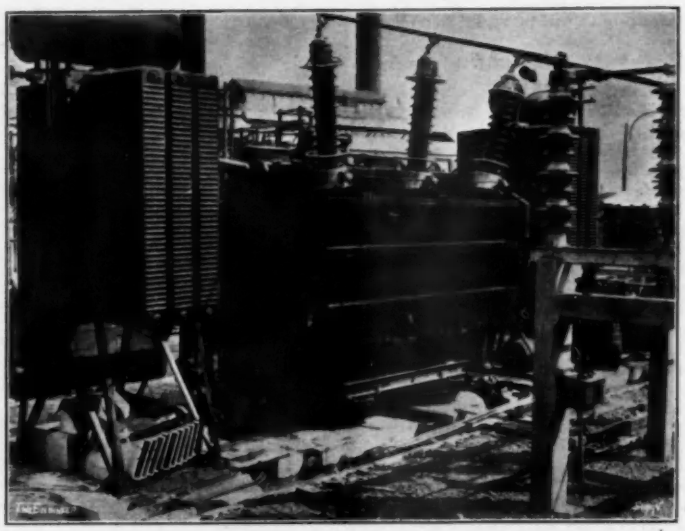


FIG. 20—20,000-kVA 3-PHASE TAP-CHANGING TRANSFORMER—FERRANTI

* No. I. appeared July 12th.

control circuit of any one bank to be put out of action. On closing the coupling switch before a bank is switched in the mechanism ensures that the bank will take up the same position of boost as the other bank or banks with which it is about to operate in parallel.

Remote indication of the tapping position is given on the control panel, the indicator taking the form of a voltmeter supplied from the control auxiliary circuit through a potential divider operated by the tap-changing mechanism. The voltage applied to the indicator varies in steps with the position of the tap changer, the indicator being scaled accordingly. An "off" position indicates that there is no voltage on the indicator circuits. This form of indicator requires only two wires for its operation and is therefore more economical to install than the usual form of lamp indicator. It is also said to be more reliable in operation.

On the tap-changing mechanism at the transformer a mechanically operated indicator is provided. There are also limit switches which prevent any movement of the gear beyond the extreme step in either direction. Except for the motor, all the mechanical and electrical equipment is manufactured at the Ferranti Hollinwood and Stalybridge factories.

Typical installations of Ferranti tap-changing on load equipment are given below, the total capacity of the gear supplied or on order being over two million kVA.

Nature of transformer.	kVA.	Voltage.	Switching method.	Reactance.
Main	300 & 500	11,000	Duplicate tap	Separate
Main	30,000	132,000	Duplicate tap	Inherent
Booster*	2,380	5,500	Single tap	Separate
Booster*	24,000	66,000	Duplicate tap	Separate
Booster*	150	240	Duplicate tap	Separate

* Circuit kVA and voltage.

The illustration Fig. 19 shows a Ferranti 7500-kVA, 66/35-kV tap-changing on load transformer, and Fig. 20 a 20,000-kVA, 132-kV transformer, also fitted with this firm's on-load tap-changing gear.

(To be continued.)

The Chicago Drainage Canal and Diversion of Lake Water.

(From a United States Correspondent.)

No. I.

NEWS of a decision of the United States Supreme Court declaring that the Sanitary District of Chicago has no lawful right for its present—and twenty-nine years' continuous—diversion of water from Lake Michigan for the dilution of sewage, may seem to those at a distance as a rather local matter or perhaps somewhat of a tempest in a teapot. As a matter of fact, this latest step, which is close to the final and conclusive step in a long controversy, has a very wide relation to problems of the rights in and uses of waters in public or Government ownership. It has not only a wide national bearing, as affecting a number of the American States, but it involves international relations and problems, since the Great Lakes are bordered by both the United States and Canada, and the people and Government of the latter are active participants in the long-drawn controversy and litigation.

There are three main aspects of this controversy. First, sewage disposal and stream pollution; second, water supply and purification; third, navigation and the fluctuating levels of the Great Lakes. In the first place, we may consider: What is the Sanitary District of Chicago, and what is its canal that has been the primary cause of twenty years of verbal, legal and technical strife.

The Chicago River, the existence of which led to the original settlement that has developed into the present city of Chicago, with a population of more than 3,000,000, was originally a small and sluggish stream with a normal flow into Lake Michigan. However, only a very low ridge or divide lying in a swampy region separated its gathering ground from that of the Des Plaines River, a tributary of the Illinois River, which in turn flows into the Mississippi, and during flood periods the head waters of the Chicago River flowed west into the valley of the Des Plaines. In fact, the French explorers of this territory in 1674 suggested a cut or channel through the divide, in order to allow canoes to pass from the lakes to the Far West instead of having to make a portage over the divide. The geographical situation may be realised from the map in Fig. 1, while the Sanitary District is shown in Fig. 2.

As the country became settled there grew up a steady demand for a navigable connection and a canal, begun in 1836, was completed to the Des Plaines River in 1848 and then to the Illinois River in 1860. Its total length was nearly a hundred miles, with 6ft. of water and several locks. In times of drought its summit level was supplied by pumping water from the Chicago River. It was obsolete and of little use long before it was superseded by the drainage canal.

As the city grew, sewers which discharged into the river and the lake were built, and as early as 1860 there were complaints of the foul condition of the almost stagnant water in the river. Occasionally storms on the catchment area would cause a sudden flow in the river and discharge into the lake, from which the city drew its water supply. Complaints thus became more and more pressing as to the taste, smell, impurity and danger of the water supply. It was then decided to lower the summit level of the old canal and to take all its water from the river, so that the latter would have a current from—instead of into—the lake. This work was completed in 1871, but the difference in elevation of the summit elevation and the lake was so small that heavy rains or strong south-west winds would start the current towards the lake.

The Drainage or Sewerage Canal.—Pollution of the river and of the lake within reach of the waterworks tunnel intakes continued to increase, so that the health and welfare of the community became endangered. In 1886 a commission of three noted engineers advocated a project for a canal to carry the river water and sewage, diluted with water from Lake Michigan, to the Des Plaines River and thus to the Mississippi. In this way the normal current of the river would be reversed, and the amount of dilution water would be sufficient to prevent any danger or nuisance along the streams.

In 1889 the Legislature of the State of Illinois passed a law creating a metropolitan district, with taxing powers, to carry out the necessary works. The official name was the Sanitary District of Chicago. Many routes were surveyed, but it was not until 1892 that a definite route was adopted and construction began. This work was notable for the great number, size and special design of machines for excavating and for removing the excavated material, in order to expedite the progress far beyond the capacity of a great army of workmen.

The length of the canal proper is 28 miles, exclusive of the 6 miles of river from the lake. It ends at Lockport in a broad basin 600ft. wide, in which vessels could turn, and on one side of which are the controlling or regulating works. The latter consist of seven Stoney sluice gates, 30ft. wide, and a bear-trap, 160ft. long, with a vertical range of 12ft. An extension of four miles leads to the hydro-electric station and locks, which were built some years after the canal was opened. The original lock for boats was 22ft. by 130ft., with 40ft. lift. The new barge lock is 110ft. by 600ft., with a lift of 43ft. In the power station, 385ft. by 70ft., are seven horizontal shaft turbines of 6000 horse-power, each driving an electric generator of 4000 kVA. A transmission line extends along the canal bank to Chicago. The canal and other works of the Sanitary District are shown in Fig. 2.

For a considerable part of its length the canal is in solid rock, with a width of 162ft. between vertical walls. In earth excavation it is 202ft. wide on the bottom and 300ft. at the top, the average depth of cutting being 35ft., with 24ft. of water. The rock section was designed for a flow of 600,000 cubic feet per minute, and its gradient was 1 in 20,000. For the earth cross section the capacity was 300,000 cubic feet per minute, as it could be enlarged when required; its gradient was 1 in 40,000.

From the very first the promoters had in mind very prominently the possibility of a navigable waterway connecting the lakes and the Gulf of

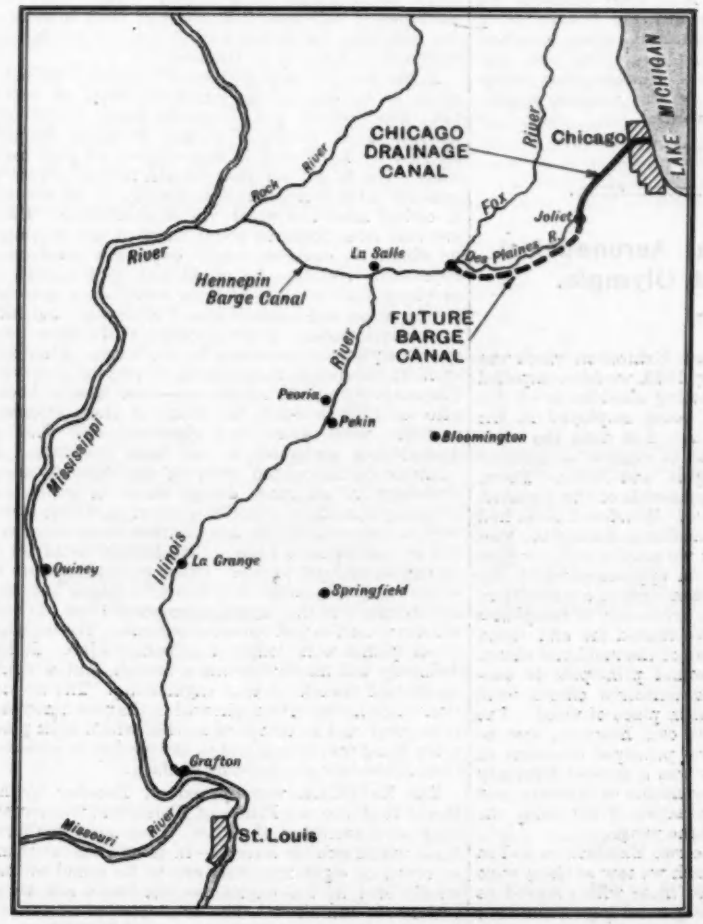


FIG. 1—CHICAGO DRAINAGE CANAL AND THE MISSISSIPPI

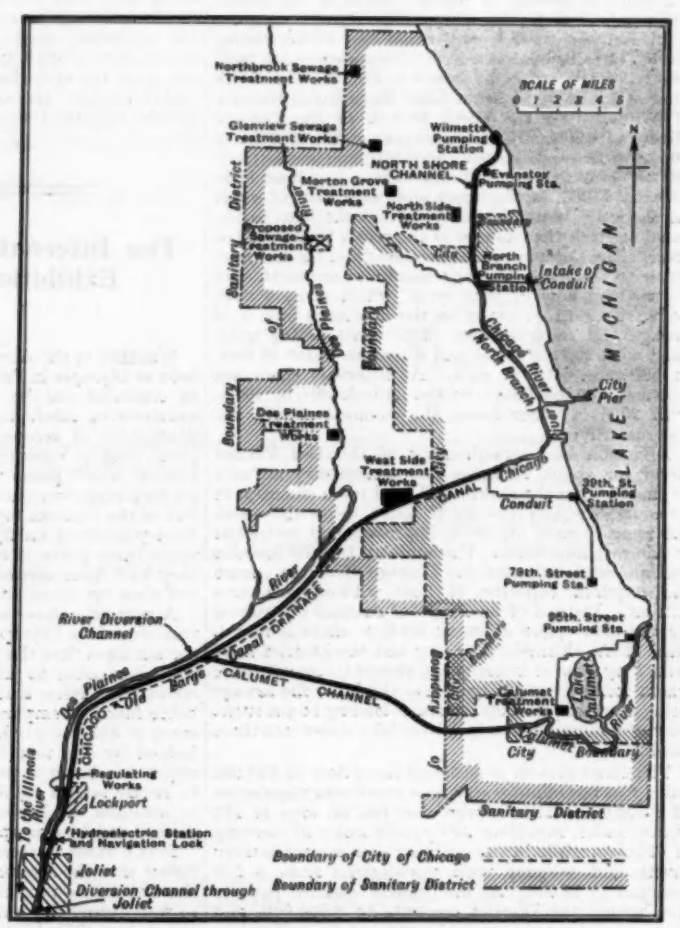


FIG. 2—CHICAGO AND ITS SANITARY DISTRICT

Mexico, and they designed the canal as a link in such a water route. It is crossed by numerous bridges, which are designed as movable structures, but they are not equipped with operating machinery since at present the canal has no outlet for navigation.

The withdrawal of such an amount of water from Lake Michigan might be expected to have some effect upon the regimen of the Great Lakes, and as all navigable waters are under the direction of the War Department, its permission was necessary for the opening of the canal. This authority was granted in 1899 for a flow of 300,000 cubic feet per minute in the Chicago River, with a velocity not exceeding 1½ miles per hour. The Secretary of War made the reservation that he intended to submit the matter to Congress, and he also reserved the right to modify or stop this flow if necessary for the protection of navigation or property interests. So far this question of the amount of diversion and the diversion of water from one watershed to another has never been submitted to Congress, and is not the subject of any direct legislation by the Federal Government. It has had successive attention from the War Department, as the Government body having jurisdiction over navigable waters.

There was strong opposition to the opening of the canal. Navigation interests opposed it on the score of a predicted rapid current in the river, it being claimed that the 1½-mile velocity would be insufficient in the river channel for the volume of water specified. There was opposition also from cities and agricultural interests below the canal on account of fear of pollution and nuisance from the sewage in the water. As the War Department's permit was subject to future action by Congress, steps were taken by the opposing interests to submit the matter to Congress. This spurred the canal authorities to strive for the completion of the work before the next assembling of the Congress.

The actual opening of the canal by cutting the barrier between its channel and the Chicago River took place on January 2nd, 1900, but without ceremony and with some secrecy in order to forestall any threatened legal action to prevent this physical completion. On January 17th the bear-trap dam was lowered, thus starting the flow into the Des Plaines River. Then with the canal open and in operation, began the long fight against the diversion of water from Lake Michigan, a fight which has not been ended by the decision rendered by the United States Supreme Court in January, 1929.

Sewage Disposal by Dilution.—Disposal of Chicago's sewage by dilution in running streams was authorised in 1889 by an Act passed by the Legislature of the State of Illinois permitting the organisation of sanitary districts. Then the Sanitary District of Chicago was created by public vote, as a corporation independent of the city or municipality of Chicago.

In addition to the main canal and its regulating works, already mentioned, this corporation has built two tributary canals, as shown in Fig. 2. The North Shore Canal extends from Lake Michigan at the city of Wilmette to the north branch of the Chicago River, 8½ miles. It has a bottom width of 26ft. to 30ft., with earth slopes, and its flow capacity is 60,000 cubic feet per minute. There is a boat lock, 28ft. by 140ft., at the upper end, with 11ft. of water on the sill. Water is pumped from the lake to the canal to flush the channel of the north branch of the river. The Calumet Canal extends from the Calumet River to the main drainage canal and serves thus to reverse the flow of that river, which is in a very polluted condition owing to the discharge into it of sewage and trade wastes. This canal is 16½ miles long, with 20ft. of water and a bottom width of 36ft. to 50ft., or 60ft. in rock. At intervals there are recesses to enable boats to pass. A lock 50ft. by 400ft. with 20ft. of water forms the connection with the Calumet River.

Diversion and straightening of the Des Plaines River for about 12 miles was a necessary adjunct to the work on the main canal, and more recently, in its course through the city of Joliet, below the canal, the river channel has been improved and restricted within retaining walls. The Sanitary District has also widened and deepened the Chicago River to ensure the required capacity of flow without excessive current. Instead of an irregular channel obstructed by the pivot piers of swing bridges, there is now a clear 200ft. channel. The city and the District have built long lines of intercepting sewers to cut off those which formerly discharged into the lake, the sewage being diverted into 20ft. conduits leading to the river. Powerful pumping plants deliver lake water into these conduits.

The canal system is designed for a flow of 600,000 cubic feet per minute, serving a maximum population of 3,000,000. The District now has an area of 442 square miles, including 200 square miles of the city of Chicago, while in the outlying area are some sixty towns and villages with populations from a few hundred to 65,000. At the present time the population within the District amounts to 3,500,000, and it is increasing at the rate of 70,000 annually. Further, the industrial wastes are estimated at the equivalent of sewage from a population of 1,500,000, and it is expected that by 1945 the total sewage and wastes will represent a population of about 7,000,000. Thus, the population is already in excess of that designed to be served by dilution in the flow of the main drainage canal. However, although the District was organised primarily to dispose of the sewage by dilution and discharge to the Illinois River, it has power to provide other means of treatment and disposal when the capacity for dilution is exceeded. By 1924 it had built and planned several large treatment plants, but only for the population in excess of 3,000,000.

New works for treatment of sewage on a large scale became necessary when the State Legislature of Illinois in 1923 amended the law under which the Sanitary District was organised. This required that, beginning with 1925, the District should put in operation, annually, works for treating or purifying the sewage from a population of 300,000, until the sewage of 60 per cent. of the total population was thus cared for. But under the recent court decision, noted above, it must provide for such treatment of all sewage, since diversion of water for sanitary purposes is not permissible.

The original authority in 1899 was for 5000 cubic feet per second, but in 1901 the War Department reduced this volume to 4167 cubic feet. In 1913 the Sanitary District requested an increase to 10,000 cubic feet, but that was refused by the Secretary of War on the ground that further diversion would interfere with navigation by lowering the lake levels. Nevertheless, since 1910 the District had allowed a flow of 7000 to 8000 cubic feet, in defiance of authority. Suits were brought to prevent this volume being abstracted, but courts and court actions move slowly.

After several years of litigation in the Federal Courts, it was held that the decision as to the amount of flow from Lake Michigan rested with the Secretary of War. In 1925, therefore, he issued a permit for a flow of 8500 cubic feet per second for a period of five years, but with the condition that within that time the District must complete sewage treatment plants sufficient to serve a population of 1,200,000. But now comes the highest court decision that no diversion for sanitary purposes is permissible, navigation being the paramount consideration.

As early as 1914 it was evident that with the growth of population the District would have to provide for the treatment of the sewage from a large population, and to discharge into the streams only the effluent from these plants. The problem is complicated by the large and increasing amount of industrial wastes of all kinds from stockyards, meat packing plants, tanneries, mills, iron and steel works, coke oven plants and miscellaneous manufacturing industries. The treatment works now in service and under construction therefore include plants for treating domestic sewage and different kinds of wastes. All these, however, are intended to serve the population in excess of the 3,000,000 whose sewage is now disposed of by the dilution system which must be abandoned in accordance with the recent high court decision. Of the seven sewage treatment plants, Fig. 2, some are on the activated sludge system and others combine sedimentation with trickling filters. The map does not show the extended system of intercepting sewers which connect the sewers of the various municipalities with the treatment works.

(To be continued.)

The International Aeronautical Exhibition at Olympia.

No. I.

WRITING of the Aeronautical Exhibition which was held at Olympia in February, 1913, we felt compelled to comment on the disquieting shoddiness of the constructive methods then being employed in the production of aeroplanes. At that date the aeroplane, engine excepted, was in general a thing of rubber, wood, piano wire, glue, and fabric. These, we remarked, were not the materials of the engineer, but of the German toy maker. Wonderful feats had been performed on flying machines during the previous three years or so, but we sought to show that they had been carried out on appliances which did not come up to engineering standards of construction.

A year or so later another exhibition of aeroplanes was staged at Olympia. We looked for and found certain signs that the builders of the machines shown were beginning to adopt sound principles of construction. Here and there tentative efforts were being made to employ metal in place of wood. The state of the art at that date can, however, best be judged by the fact that the principal direction in which we detected progress was a general tendency to secure lateral stability by means of ailerons, and to abandon the barbarous practice of obtaining the desired end by a warping of the wings.

It is curious to recall these two Exhibitions and to reflect that the machines which we saw at them were the immediate progenitors of those which served us so well during the war. The general impression that the years 1914–18 witnessed an almost incredible development of the aeroplane is, nevertheless, not quite correct. The performance of the machines was certainly improved out of all recognition, and the facilities for their production were increased a thousandfold. From the constructional point of view, however, the progress made was much less marked. The fundamental methods of aeroplane construction were substantially the same at the end of the war as at its beginning. Energies had been concentrated on the improvement of performance and on output. It was no time for experiment. Any developments which did not react beneficially on the performance or output had little chance of receiving consideration. Towards the closing stages of the war there was a distinct tendency in the direction of using metal as the main material in aeroplane construction. That movement, however, was inspired by the fact that great difficulty was being experienced in maintaining the supply of spruce and other aeroplane timbers. For some years after the war, when timber of suitable quality in suitable lengths again became available, many makers of aircraft continued to look askance on metal as a material of construction. They were loath to give up wood, and the manufacturing processes associated with it, which had been used or developed during the trying days of the war. At the Aeronautical Exhibition held at Olympia in July, 1920, we noted that in many highly important respects construction seemed to have become stereotyped, that the makers still adhered to wood, linen fabric, glue, stitching and "dope," and that, with one exception, none of the exhibitors appeared to have studied, seriously, alternative methods of construction. Of the fifteen British and one French firms exhibiting aeroplanes at that Show, only one—Messrs. Short—had on view a machine of the "all-metal" type. The "Silver Streak" was, in our opinion, an engineering structure in the proper sense of the term. It contained not one particle of wood or fabric. Even the wing covering was of aluminium. It was a bold pioneering experiment, and to it we may reasonably trace a good deal of the interest which shortly afterwards the Air Ministry began to show in metal construction.

And now, after nine years, another Aeronautical Exhibition is being held at Olympia. The machines on view represent the revolution which has been wrought in aeroplane constructive methods since 1920. To-day it is difficult to find in the hall an "all-wood" machine. There is certainly one, but it has been built of wood only to try out the design, and when the tests are completed succeeding machines of the type will, the makers are particular to explain, be built of metal. The "all-metal" machine is the rule, not the solitary exception, at Olympia to-day. Here and there, wood still lingers in certain composite designs, but even in these machines steel or aluminium alloy forms the principal portion of the stress-bearing structure. From the constructional point of view, the machines now being shown are separated from those of the Exhibition of 1920—the Short "Silver Streak" excepted—by a far bigger and more fundamental evolutionary stage than the machines of 1920 were from those of 1913, in spite of the fact that the earlier period covered the intense aeronautical activity of the war.

In the past, we have been severe critics of the aeroplane as an engineering structure, with, we maintain, good reason and, it would seem, not wholly without good results. To-day Olympia justifies all that we have said on this subject on past occasions. We do not say that we can find no points to criticise in the construction and design of the seventy to eighty machines which are on exhibition. There are still some features about most of the machines to which an engineer might express a puritanical objection. Notably, he might feel bold enough to prophesy that the use of linen fabric as a covering for the wings and fuselage of an "all-metal" machine is an anachronism. Some machines at the Show have metal or plywood coverings for the wings. They are, without exception, monoplanes, it may be observed. The majority of the exhibitors—even Messrs. Short, who in 1920 covered the wings of their all-metal machine with aluminium sheeting—still find it desirable or preferable to use linen coverings. It seems to be undoubted that, for the moment, metal coverings, in all cases except those in which the covering is made to contribute strength to the structure, are uneconomically heavier than linen coverings. We are unwilling to believe that developments are at an end in this connection. Other points there are to which exception might reasonably be taken, but they are no longer of the same fundamental order as those which we used to find reason to criticise. The building of aeroplanes is no longer a carpenter's job. It has definitely and finally become a branch, and a highly specialised branch, of true engineering. The revolution which has been wrought within the past nine years is as great and as complete as that which took place when wood was abandoned in favour first of iron and then of steel for the building of ships.

The Exhibition was opened on Tuesday by his Royal Highness the Prince of Wales, and will remain open until Saturday, the 27th. There are some forty firms which exhibit aircraft—in some cases as many as seven or eight machines are to be found on one stand—and in the engine section there are about twenty-six exhibitors. The exhibitors of accessories and miscellaneous supplies connected with the production or operation of aircraft number not far short of two hundred. British exhibitors are naturally in the majority, but France, Germany, Italy, and the United States are also well represented. Below we begin an account of some of the principal new machines included in the Exhibition, while in our two-page

Supplement we illustrate a selection from among the British aircraft.

THE GLOSTER AIRCRAFT COMPANY, LTD.

A striking illustration of the developments that have taken place during the last twelve years or so in the use of metal for wing structures is to be found on the stand of the Gloster Aircraft Company, Ltd., of Cheltenham. In conjunction with its associate, the Steel Wing Company, Ltd., the Gloster Company has brought together a historical collection of metal wings in the construction of which use is made of corregated strip. The wings exhibited represent six different designs, the earliest being one produced in 1917 for the B.E.2d machine, and the latest one evolved late in 1928 for the de Havilland "Moth." In the earlier designs use was made exclusively of high tensile alloy steel strip, but latterly there has been a manifest tendency towards the use of aluminium for some members of the wing structure. For example, in the "Moth" wing, while the spars are formed of corrugated high tensile alloy steel, the ribs are each a one-piece pressing from aluminium. It is of interest to note that in the development of these metal wing structures there has not been a progressive reduction in the weight. In 1917 the B.E.2d wing weighed 0·58 lb. per square foot of area without the covering. In the case of the Avro 504 K wing, designed in 1918, the corresponding weight was 0·62 lb. In 1923 the Avro "Aldershot" wing weighed over 0·7 lb. per square foot, while in the Gloster "Gamecock" wing of 1926 the weight rose to 1·09 lb. This steady increase in the unital weight showed a slight reduction in 1928, when a metal wing for the Westland "Wapiti" machine was produced with a weight of 0·95 lb. per square foot in the uncovered condition. In the case of the latest example exhibited, the steel and aluminium structure for the "Moth," the weight has fallen down to 0·5 lb. per square foot. It should perhaps be remarked that these unital weights are not strictly comparable, for the wings to which they relate are not all of the same pattern and differ very much as regards size.

Another exhibit on this company's stand which attracts much attention is the Gloster-Hele-Shaw-Beacham variable pitch airscrew. A good deal has been heard of this device during the past two or three years, but this is probably the first occasion that has been available to many to make a close inspection of a full sized example of it.

The device is illustrated in Fig. 1. The blades B B are mounted so as to be capable of being rotated in the hub A, the centrifugal pull being taken on ball thrust bearings. The airscrew shaft C drives the hub through splines or keys. Rigidly fixed to the hub is a piston D. Three holes 1, 2, 3, in the boss of the piston register with three holes in a boss of the hub which projects rearwards. A cylinder E surrounds the piston, and is capable of sliding axially relatively to the piston and hub. This cylinder carries two projections which engage with crank pins F fixed to the blades. The displacement of the cylinder to the right or left therefore causes the blades to turn in one direction or the other.

A fixed sleeve R surrounds the rearwardly projecting boss of the hub, and establishes continuous connections between the three pipes 1, 2 and 3 and the corresponding ducts in the rotating hub and piston. The delivery of oil to one side of the piston D and its extraction at an equal rate from the other, causes the cylinder E to move longitudinally and so to turn the blades. The flow of oil to the cylinder is controlled by a pump having three radially-disposed cylinders. The cylinders are formed in one piece and are integral with a spindle S, which is geared to and driven by the engine. The pump pistons revolve about a crank pin T, which is adjustable in a vertical direction, so that it may be set above, below or coincident with the spindle S. This adjustment is effected by means of a rod V attached to the crank pin T and linked at H to a centrifugal governor K, which is driven off the pump spindle S, which, as has already been stated, is directly driven by the engine. Two pipes lead from the pump to the sleeve R. Branches from these two pipes are taken to a small box containing non-return valves L, the box in turn communicating with an oil tank.

With the crank pin set above the axis of the pump spindle, rotation of the pump cylinders in the direction of the arrow will withdraw oil from pipe 2 and deliver it into pipe 1. With the crank pin below the axis of the pump spindle, the oil flow will be in the reverse direction. With the crank pin central no flow takes place. Hence the airscrew blades will be turned in one direction or the other, or be held stationary according as the pump crank pin is above or below or coincident with the axis of the pump spindle. When the cylinder E reaches either end of its travel the ports P are uncovered, and the pressure pipe 1 or 2 is connected by way of the pipe 3 with the oil tank. In this way excessive pressures are avoided.

The arrangement of the governor is such that when the engine speed is normal the crank pin T is coincident with the spindle S. Should the engine speed increase the governor K causes the crank pin T to rise, with the result that the cylinder E moves to the left and the pitch of the blades increases. This process continues until the extra airscrew torque produced by the increased pitch, brings the engine speed back to the normal. A reduction of the engine speed has the reverse effect, namely, that of decreasing the pitch of the blades. Hence there is only one speed at which the engine can run, namely, that corresponding to the mid position of the governor. An auxiliary spring M, the tension of which is controlled by the hand wheel N enables the pilot to modify the action of the governor to give the engine any desired speed.

A very interesting machine is included among the Gloster Company's exhibits, namely, one which has recently been specially designed and constructed for survey work, the first specifically built, it is claimed, for this important field of aeronautical activity. The Gloster "Survey" is an all-metal twin-engined biplane having a wing span of 61ft. Its engines are two Bristol "Jupiters" of the Mark XI. geared type, giving 465 H.P. each, although various other engines can be fitted. We illustrate the machine in Fig. 2.

For the particular purpose for which this machine is intended, it is important that the materials used

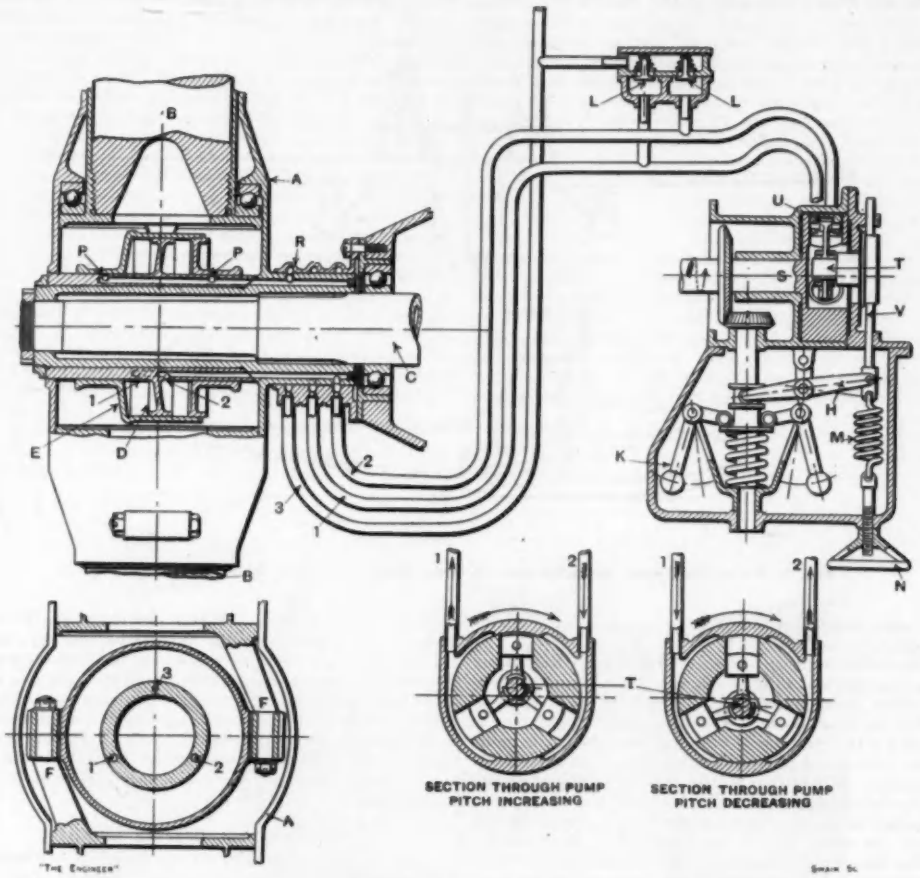


FIG. 1—GLOSTER-HELE-SHAW-BEACHAM VARIABLE-PITCH AIRSCREW

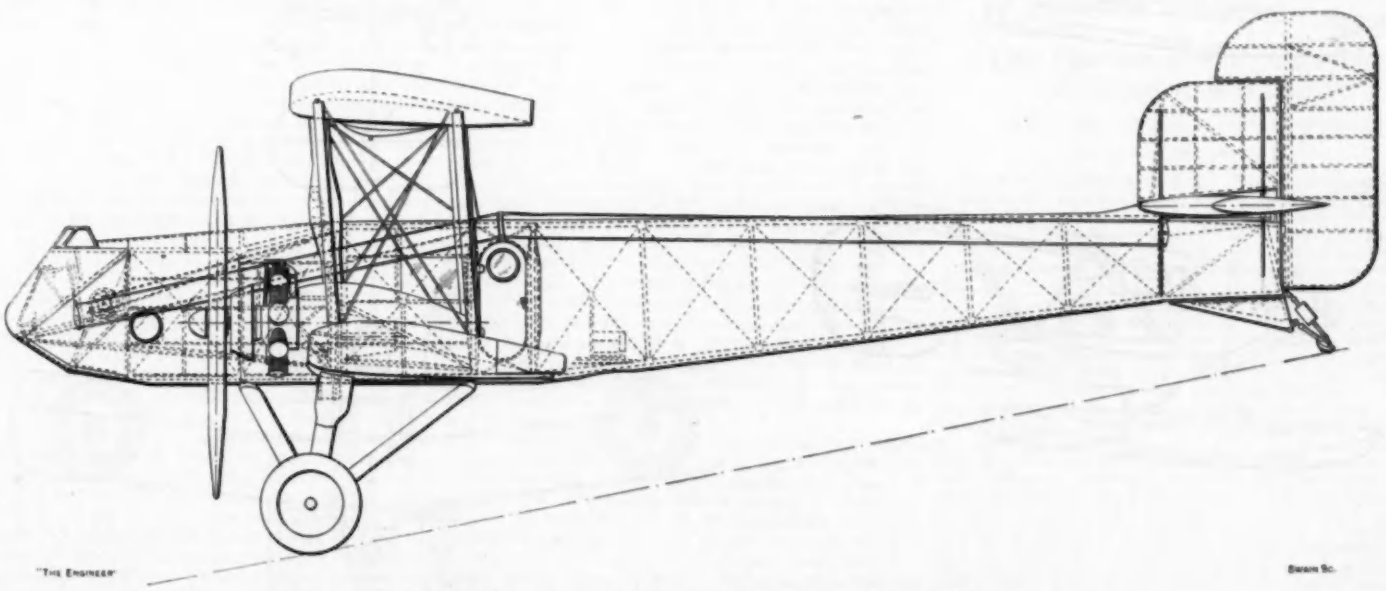


FIG. 2—TWIN-ENGINED, ALL-METAL "SURVEY" BIPLANE—GLOSTER

in its construction should be able to resist all types of climatic conditions, and, in addition, ease of transport in possibly difficult country or by sea, demands that all large components should be readily detachable. It is also important that easy accessibility should be given to all parts, so that inspection and repair may be carried out with the least possible difficulty under conditions which may be unusual.

All the main structural members of the "Survey" are of steel or duralumin, protection from corrosion being secured by stove enamelling or by anodic treatment. The wing spars, of the company's lattice type, are of high tensile steel. The duralumin ribs are bolted to the spars in three sections, the leading edge, the centre section and the trailing portion, so that any rib, if damaged, can easily be replaced under service conditions. The fabric is fixed to the ribs by means of rustless wire threaded through eyelets formed in the ribs and locked under the heads of the bolts attaching the leading and trailing edges.

The fuselage is made in three detachable sections composed mainly of steel and duralumin. The two front portions are built up of square sectioned tubing with flat plate joints of a very simple design. The rear portion of the fuselage is made of round tubing with pressed wrapper plate joints. Steel and duralumin are also employed for the tail plane, rudder and fin. Two triangulated vee structures constitute the undercarriage, the arrangement being such that the usual long axle close to the ground, an element which is unsuitable for operation in rough country, is eliminated.

Dual control is provided in the pilot's cockpit in the nose of the machine. Tie rods in place of the usual stranded cable are employed to operate the control organs in order to avoid trouble from stretching and all the important bearings in the control system are fitted with grease gun lubricators. The pilot's cockpit is accessible from the main cabin through a door. It is open above the pilot's head, but below his feet it is formed with windows. In the photographer's cabin three separate camera positions are provided. A Bristol gas starter for the engines is included in the equipment.

The machine has a ceiling of 21,900ft., and with a normal load of 800 lb. plus 200 gallons of fuel and 27 gallons of oil, can attain a speed of 131 m.p.h. at 1000ft. and of 114 m.p.h. at 20,000ft. With only one engine running the machine can maintain itself in flight, and can, in fact, reach a ceiling of 10,400ft. when normally loaded. We learn that the machine is now being produced in a convertible type capable of carrying six or eight passengers.

S. E. Saunders, Ltd.

The small, four-seater twin-engined monoplane flying boat—see Fig. 3 and Supplement—is exhibited by S. E. Saunders, Ltd., of East Cowes, and is of particular interest in that it represents a combination of wood and metal construction. The hull within which the pilot and passengers are accommodated is constructed of "Alclad" protected duralumin, and on it is mounted a cantilever wing of wooden construction entirely covered with plywood. Two "Hermes" engines totalling 210 H.P. are mounted on top of the wings, although alternative arrangements with one 200 H.P. engine or three engines of 80 H.P. each are possible. Two alternative constructions of the wing are provided in the design. In one the wing is a single member from tip to tip. In the other the wing is divided into three sections by joints situated just beyond the wing floats. In both forms the wing is attached to the hull by four bolts.

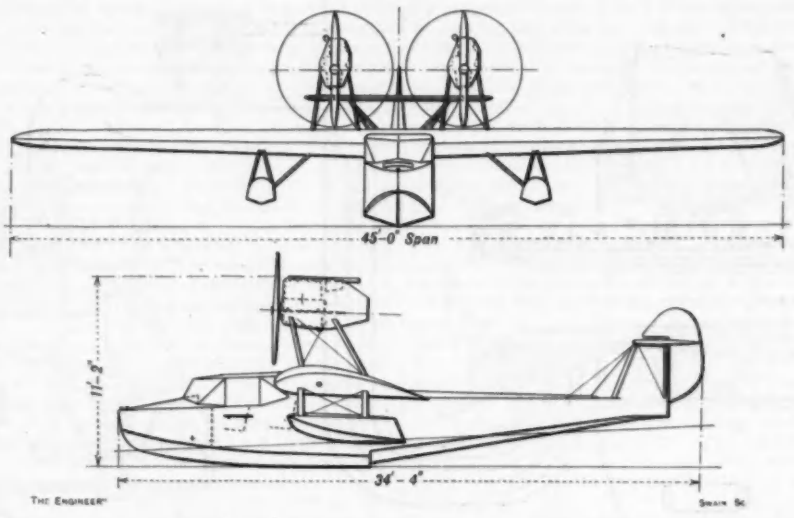


FIG. 3—TWIN-ENGINED, MONOPLANE FLYING BOAT "CUTTY SARK"—SAUNDERS

The wing is divided into a large number of buoyancy compartments.

The hull is built up of straight frames and flat plates in a manner, which, it is claimed, makes it quite easy to effect even extensive repairs. At the forward end of the boat there is a compartment covered by a hatch for the stowage of mooring gear, &c. The main cabin is situated in front of the wing, and is entirely enclosed. In addition to the normal means of access to the cabin, emergency exits are provided in the roof. Luggage or mails can be carried in a compartment under the wing, and in another within the wing aft of the rear spar. Access to the second-named compartment is obtained through a hatch in the wing.

The engines are carried on two detachable mountings, and can be started by the pilot by a remote control system operated from within the hull. Tankage is provided for 40 gallons of petrol. The main tanks are situated within the wings, and from them petrol is pumped to small gravity tanks arranged behind the engines. Should the pump fail, flight can be carried on for half an hour by means of the fuel in the gravity tanks.

The fin is built up from the hull and carries a monoplane tail of steel construction and having a fabric covering. The rudder is also of steel construction. Dual control gear, not normally carried, can be attached in a few minutes when desired. To assist the manœuvring of the machine on the water it is fitted with a new form of drogue. This device consists of plates hinged to the side of the boat and operated by the pilot. When moorings are to be picked up the pilot extends both flaps and throttles the engines right back. The speed of the boat through the water is, as a result, reduced, and steering can be effectively carried out by means of the engines. During this operation the pilot stands up, a hinged wind screen over his head permitting him to do so. In this position he can still reach the engine throttle controls and at the same time operate a patented boat hook for picking up his moorings.

George Parnall and Co.

A machine of great interest on the stand of George Parnall and Co., of Bristol, is the "Peto"—Fig. 4; see also the Supplement—a two-seater reconnaissance seaplane designed for service use in conjunction with submarines. As is now well known, certain British submarines are equipped to carry a small light aeroplane which can be folded and stowed away in a very small space. The "Peto" is such a machine. It

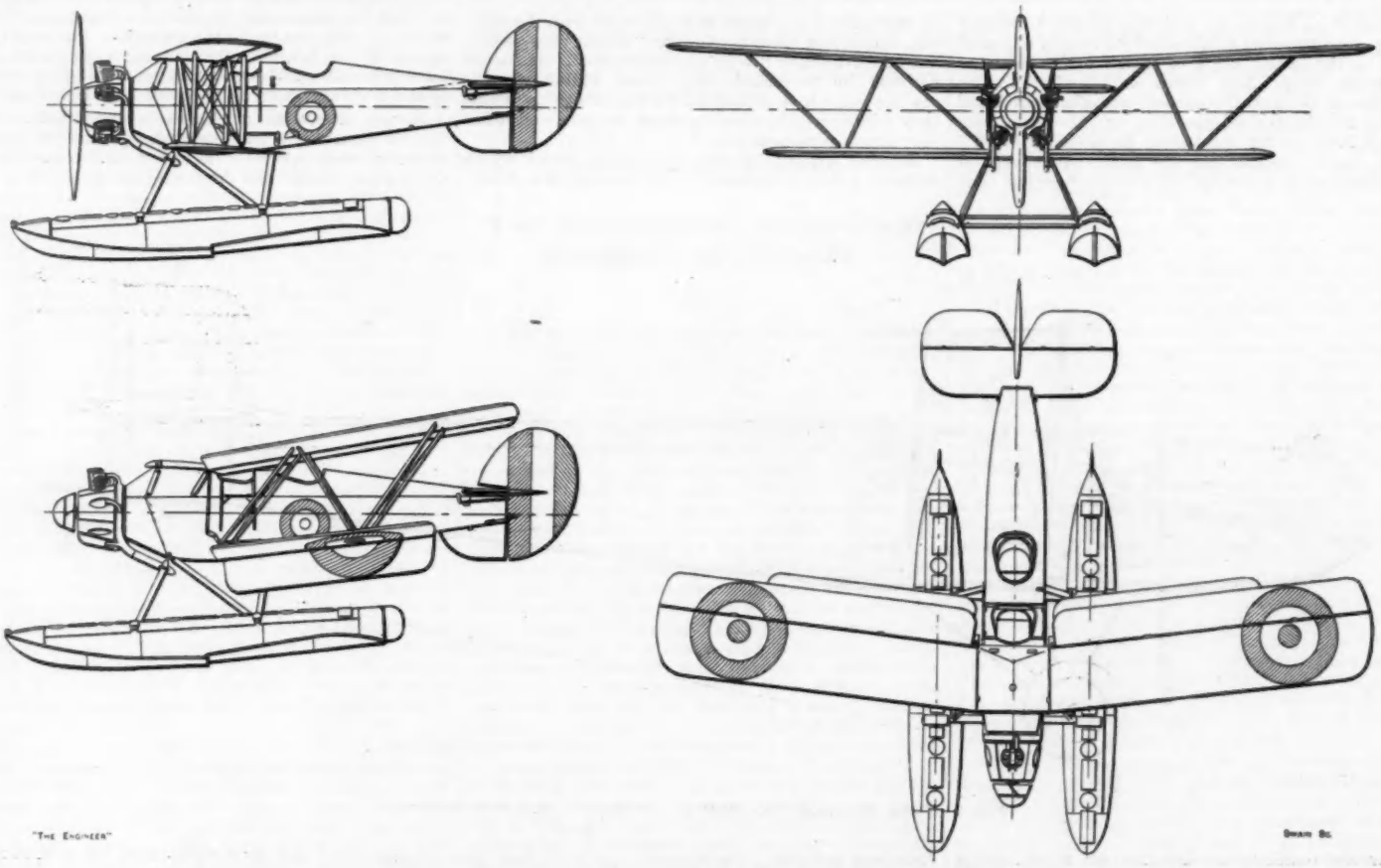


FIG. 4—TWO-SEATER, SUBMARINE SEAPLANE "PETO"—PARNALL

can be launched from or stowed away in its submarine in a very short interval of time. In addition, it has been designed with provision for launching by means of a catapult. Its construction is composite, stainless steel, duralumin and spruce all entering into it.

The upper wings when extended have a span of 28ft. 5in., and the lower a span of 20ft. 5in. When the wings are folded the width is reduced to 8ft. The height of the machine is 8ft. 11in. and its length 22ft. 6½in. Its weight when empty is 1300 lb., and when loaded 1950 lb. At sea level it has a speed of 113 m.p.h. Its range is two hours. Ailerons, externally operated, extend along the full length of the upper wings. What appear to be ailerons on the lower wings are in reality flaps which are lowered when the machine is folded. The wing spars and ribs are of spruce, but steel tubing is used for the centre section, the aileron spars and for the interplane struts. The fuselage structure is also composite, the longerons being of spruce and the struts being partly spruce and partly stainless steel. A covering of fabric is employed for the body except at the sides of the front cockpit, which are clothed with detachable aluminium panels. The fabric-covered tail unit is also of composite structure. A noticeable feature in the design is the fact that the tail fin is underhung. The undercarriage is composed of streamline steel struts of N form, as seen in side elevation. Single-step duralumin floats are carried cantilever-wise by the undercarriage at a centres distance of 6ft. 0½in. These floats can be readily removed without interfering with the bracing of the undercarriage.

The engine is an Armstrong-Siddeley "Mongoose," of 135 H.P. A hand starting gear is provided in the passenger's cockpit. In a gravity tank fitted inside the fuselage 14½ gallons of petrol can be carried, while below this tank there is another holding 1½ gallons of oil. The pilot's and passengers' cockpits are fitted with seats capable of accommodating parachutes or air cushions. The passenger is provided with a chart case, observation instruments, and a short-wave wireless transmitting and receiving set.

Messrs. Parnall also show a new two-seater light tractor biplane, the "Elf," which in some respects may be regarded as the civil version of the "Peto." This machine, of which views in the folded condition are given in Fig. 5, is built as a land machine or as a seaplane. It is of composite wood and metal construction, and is driven by a 105 H.P. "Hermes" engine, the cruising speed being about 100 m.p.h., and the range about 400 miles. As in the "Peto" service machine, the pilot and passenger are so seated that their lines of vision are level with the centre section of the wings. This centre section is kept thin and does not, as in some light aeroplanes, support or contain the main petrol tank, that tank in the "Elf" being situated inside the fuselage. The elimination of wire bracing between the wings and the substitution therefor of a bracing system of streamline steel tubes arranged in the form of a Warren girder—as in the "Peto"—reduces the time and expense spent on the maintenance of the machine. Flaps are provided on the lower wings for folding purposes. When folded the machine has an overall width of only 7ft. 11in., or a good 18in. less than the folded width of most other light machines. The machine is fitted with dual control, and is equipped with lockers of ample size to carry suit cases, sporting and camping equipment, &c. Although the maximum ground level speed is about 116 m.p.h., the stalling speed is as low as 40 m.p.h.

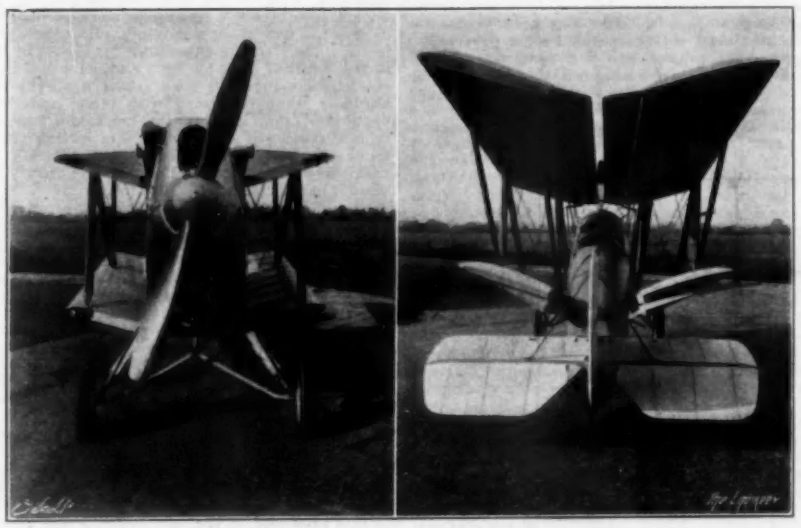


FIG. 5—TWO-SEATER LIGHT AEROPLANE "ELF"—PARNALL

THE FAIREY AVIATION COMPANY.

One of the largest exhibits in the hall is that of the Fairey Aviation Company, Ltd., of Hayes, Middlesex. On this company's stand no fewer than seven different types of aircraft are shown, in addition to a collection of metal air screws, metal floats for seaplanes, gun mountings, &c.

Of some of the machines exhibited, such as the "Fox" and the "III. F," we have published illustrations and descriptions on previous occasions, notably of the "III. F." in our issue of January 11th this year. Special interest attaches to one of the company's exhibits, namely, the long-range monoplane, which, only because of unusually bad weather on the England-to-India route, recently just failed to establish a world's distance record. This machine, illustrated in the Supplement, has a wing span of 82ft., and an overall length of 48½ft. Its wing is constructed as a pure cantilever, and has a thickness, chord, and angle of incidence, which vary throughout the span. The tail is also a cantilever structure. In fact, the only external bracing wires on the machine are those supporting the tail fin. The internal bracing of the wing is of a patented type, designed to overcome the trouble arising during manœuvring from twisting of the wing structure which has often been encountered in cantilever monoplanes with fabric-covered wings. The undercarriage is of a normal design except that the wheel track is of unusual width to give good stability on the ground. The wheels are mounted on roller bearings to facilitate the taking off of the machine, always a difficult and frequently a dangerous operation in a heavily loaded long-distance machine. The engine is a normal Napier "Lion" fitted with pistons designed to give a compression ratio slightly higher than in the standard design.

Over a thousand gallons of fuel are carried in tanks inside the wing structure. From these tanks the petrol is fed by gravity to a collector tank under the cabin floor, and from there is pumped to the engine. If the engine pump should fail, a wind-driven pump can be immediately pushed through the side of the fuselage to take up the feed, and if that pump should also fail the supply can be continued by means of a hand pump. Two main oil filters are provided so that while one is in action the other may be idle for cleaning. The cabin is totally enclosed. All the windows, of "Triplex" glass, can be opened for ventilation, and are fitted with equipment for cleaning them. The navigator can look downwards through the wing, upwards through a roof light, and downwards through a floor sight, the last-named sight being specially intended to facilitate the taking of drift observations. The navigator is provided with a seat and table at which to work. The pilot's seat is furnished with pneumatic upholstery, and in the cabin there is a pneumatic bed. Among the instruments with which the machine is fitted is a device which, if the machine departs inadvertently from its course, either vertically or directionally, blows a hooter in the pilot's ear.

Before the construction of this machine was begun, the aerodynamics of the design were checked by exhaustive wind tunnel tests at the National Physical Laboratory. Thereafter half a wing was made and tested under full load for all conditions of flight. When the fuselage had been erected, the rear end was loaded up to test the torsional rigidity of the structure under fin and tail loads. Other tests carried out consisted of applying to a wheel a load in excess of any that would occur during the landing of the machine and the running of an identical engine for seventy hours on the bench under the conditions encountered on the route to India. The machine succeeded in flying non-stop from Cranwell aerodrome to beyond Karachi. It was forced to land by reason of a shortage of petrol. As we recorded at the time, its failure to establish a world's long-distance record was not in any way ascribable to structural or other defects. It remains available, and will shortly, no doubt, be used for a fresh attempt on the record.

A. V. ROE AND CO., LTD.

Of the machines shown by A. V. Roe and Co., Ltd., of Manchester, chief interest will probably be found in the "Avro Ten," a three-engined monoplane fitted to carry eight passengers. This machine—illustrated in the Supplement—is a British-built version of the Fokker "F VII.-3 m." machine, and is constructed by Messrs. Roe under licence from the N.V. Nederlandsche Vliegtuigenfabriek. The machine is fitted with dual control for two pilots. With eight passengers on board and carrying fuel and oil for four hours' flight at the cruising speed of 100 m.p.h., it has a gross weight of 9921 lb., of which 1800 lb. represents the paying load. When fully loaded the machine can maintain level flight with one of its three Armstrong-Siddeley "Lynx" engines—230 H.P. each—shut off. Three baggage compartments, with a total capacity of 114 cubic feet, are arranged within the fuselage.

The fuselage is constructed on the Fokker system, involving the use of tubular steel, with welded joints, and bracing consisting of steel struts and high-tensile steel wire. The fuselage covering is of doped linen. The undercarriage is in two similar parts, each consisting of two steel tubes hinged to the side of the fuselage, and a long vertical buffer strut attached at its upper end to the outboard engine bearer. There is no transverse axle. The shock of landing is absorbed on rubber rings. The outboard engine mountings are suspended from the wing spars, the attachment in each case being made by means of three bolts. The centre engine mounting is attached to the fuselage by four bolts. An oil tank is situated behind each engine. In the wing, tanks are provided for 150 gallons of petrol. The wing is a cantilever construction, and is built in one unit without internal or external bracing. It is composed entirely of wood, and is covered with plywood. The machine can take off after a run of 275 yards and pulls up in 330 yards. If wheel brakes are fitted, the landing run is reduced to 230 yards.

Messrs. Roe also exhibit the "Avro Five" a small cabin monoplane fitted with three Armstrong-Siddeley "Genet Major" engines of 105 H.P. each. This machine provides accommodation for four or five passengers. The pilot sits in a completely enclosed compartment in front of the leading edge of the wing and has a very good view in all directions forward as well as below. The construction of the machine is generally similar to that of the "Avro Ten." The Avro "Antelope," a two-seater day bombing reconnaissance and fighter biplane, driven by a 538 H.P. Rolls-Royce F. XI. B. engine, is also included among the firm's exhibits. This machine has a speed of about 170 m.p.h. at 6000ft. Constructionally it is interesting because of the fact that its fuselage is composed of duralumin channelling covered with riveted-on duralumin plates. This type of construction forms a very rigid structure, and does not require periodical truing up. The main planes are composed of duralumin spars and ribs, with stainless steel fittings and coverings of doped linen.

Of the four other machines illustrated in our Supplement, we shall give some account in our succeeding issues.

(To be continued.)

The Hardness and Abrasion Testing of Metals.*

By G. A. HANKINS, D.Sc., Associate Member.

(Continued from page 35.)

(*b*) *Diamond Indentation Tests.*—Brinell, in his original paper on the ball test, gave Brinell numbers as high as 744, and has since given 1100, but the extensive use of the test soon proved that the steel ball was not reliable for indentation tests on very hard steels, and showed that a more satisfactory method was required for such materials. In order to encourage workers in their search for such a test, the Institution of Mechanical Engineers, through the generosity of Sir Robert Hadfield, was enabled to offer a substantial prize for a successful solution of the problem, and although at the time no entirely satisfactory method was evolved, so much impetus was given to the study of alternative methods that a satisfactory solution has now been obtained in the diamond indentation hardness test. In this country, Smith and Sandland, the originators of the well-known Vickers Diamond Hardness Testing Machine, deserve most credit for the development of the test, while in America, Rockwell has developed the diamond hardness machine associated with his name.

Shore, in 1918, gave the results of indentation tests carried out with a diamond ball, using loads of 500 kilos. and 750 kilos., and his results showed quite definitely that the diamond ball was more satisfactory than a steel ball on very hard steels. Smith and Sandland made a definite step in the right direction in 1922, when they showed that an uncut pyramidal diamond could be used for indentation tests provided a constant size of impression was used. This condition was obviously necessary with an uncut diamond, and was likely to limit the use of such a test, but the substitution of a good polished pyramidal diamond for the uncut diamond, automatically gave similar impressions for any load, and enabled a satisfactory commercial test to be developed. The indenting tool finaly adopted by Smith and Sandlands is a polished pyramidal

* The Institution of Mechanical Engineers. Hardness Tests Research Committee. Issued for written discussion, which closed on June 30th, 1929.

diamond with an angle of 136 deg. across the facets, and this angle was used as it gives an impression that approximates to a 3·75 mm. diameter impression produced by a 10 mm. ball. The actual test is made in a similar manner to the Brinell test, and the result is obtained from the measured diameter of the square impression by means of the usual type of formula, namely :—

$$\text{Hardness number} = \frac{\text{load (kilos.)}}{\text{impressed area of indentation in sq. mm.}}$$

As would be expected with an indenter which gives approximately geometrically similar impressions, the hardness number of a given material is independent of the applied load. Experiment has shown that the results agree with the standard Brinell test up to about 350 Brinell number. Above this figure, the general character of the diamond test remains almost unchanged by the test material and diamond pyramid numbers of the order of 900 have been obtained, whereas a steel ball on the same material is appreciably deformed and gives Brinell numbers of the order of 740. At present the main value of the diamond test lies in the region above 350 Brinell number, and it enables accurate comparative indentation tests to be made on the hardest steels.

In the Rockwell test, the indenting tool consists of a 120 deg. diamond cone with a rounded point, and the depth of the indentation is automatically recorded on a dial indicator. In actual use the machine applies a load of 10 kilos. called the "minor" load, and the depth indicator is set to 100. The load is then increased to 150 kilos., called the "major" load, and the indicator records the increase in depth of the indentation caused by the additional load of 140 kilos. The increase in depth is observed after the additional 140 kilos. load has been removed. The readings are shown by the pointer of the dial indicator, and the value 100 minus the additional depth is called the Rockwell number C scale. The result is thus a linear measurement in arbitrary units of the difference in depth between the indentations caused by the major and minor loads. The machine can also be used for similar depth measurements with steel balls in place of the diamond indenter. A $\frac{1}{16}$in. diameter steel ball is generally used, and the results obtained with 100 kilos. major load are known as Rockwell number B scale. Im both diamond cone and steel ball Rockwell tests, no microscope measurement of indentation is required. The use of linear dimensions and constant load causes the openness of the scale to diminish with increasing hardness of the test material, an obvious disadvantage, but, on the other hand, the machine is quick and simple in use and the reading is direct, two very important advantages in industrial use.

In the Firth hardometer the form of the diamond indenter is a square pyramid with an angle of 140 deg. across the facets, and the principle of the test is similar to that of the Vickers test. A static indentation hardness testing machine is now being developed by the makers of the Shore Scleroscope, and in this new machine a diamond ball indenter is used. The machine is arranged to give impressions of constant depth, and microscope measurements are not necessary in obtaining test results.

In the opinion of the author, the diamond indentation test has already proved its value, and wider experience will probably lead to its enhanced popularity with manufacturers and investigators who deal with all forms of hardened steel. Indeed, it seems probable that manufacturers who use the diamond test will be inclined to extend it to soft steels and non-ferrous metal in preference to the steel ball Brinell test.

Comparison of Brinell, Rockwell, and Diamond Pyramid Scales.—The development of the diamond test has resulted in the wide use of further scales for expressing the results of indentation hardness tests, and it is important to consider the relation of these scales to the results given by the standard Brinell test. Considering first the Rockwell C scale, and remembering that it is based on a linear depth measurement, it is apparent that an approximate straight-line conversion curve can be obtained for Rockwell C numbers and Brinell diameter observations. For the reasons given above with regard to depth measurements of impressions, the conversion relation cannot be quite the same for all materials. Similarly for the Rockwell B scale, an approximate straight-line relation holds for conversion to Brinell diameters. Fig. 1 gives a direct comparison of Rockwell C scale and standard Brinell numbers obtained in tests carried out by the author, and the curve shows distinctly the convergence of the Rockwell scale with increasing Brinell number. The breakdown of the steel ball test at about 520 Brinell number is distinctly shown. An extensive comparison of the Rockwell numbers and Brinell numbers has recently been carried out at the Bureau of Standards, and conversion formulæ have been obtained by means of which the Brinell number may be obtained from the Rockwell number with an accuracy of ± 10 per cent. Formulæ have also been obtained whereby the tensile strength of steel may be estimated from the Rockwell number with an accuracy of ± 15 per cent. For non-ferrous metals no discernible relation was found between Rockwell numbers and tensile strength.

In regard to the Vickers diamond pyramid test scale given on right of Fig. 1, the actual numerical results are in fair agreement with standard Brinell numbers from 100 to 350; from 350 to 500 the pyramid test gives values which are slightly higher than Brinell numbers. A conversion curve is given in Fig. 1. Direct microscope measurement of Rockwell diamond impressions can obviously be used to express the 120 deg. diamond cone results in the usual form of load/area. The type of curve then obtained is shown in Fig. 1.

In considering the relations between diamond tests and the steel ball Brinell test, it is noticeable that the results are irregular beyond 500 Brinell number, and apparently variations in the quality of the balls account for the irregularities. Mailander has carried out Brinell tests with balls of varying degrees of hardness, and concludes that the limit up to which ordinary hard steel balls are sufficiently accurate is about 420 to 450 Brinell number. This result agrees with the author's conclusion that the 120 deg. diamond cone (corrected for friction or adhesion), 136 deg. diamond pyramid, and Brinell steel ball results are in fair agreement up to 440 Brinell number and with Batson's experimental results that marked flattening of the ball commences at 440 Brinell number. Mailander also found that the satisfactory limit of accuracy was about 460 to 500 for specially hardened cold-worked steel balls. These results suggest that it may be necessary, in the near future, to standardise some form of diamond indentation test for values over 450 Brinell number, so that unnecessary confusion may be avoided. The chief point to be considered in any such standardisation appears to be the selection of a diamond pyramid or cone to give the same result as the standard steel ball test at 440 Brinell number, and over as great a range as possible below this figure. The load need not be specified for a pyramid or cone indenter. The present 136 deg. pyramid approximately fulfils these requirements, but the variations in the shape of the indentations on certain materials (they are seldom exact squares) appear to be drawbacks in a standard test, although they may be useful indications of the work-hardening properties of the test materials. A diamond cone normally gives a circular impression and for this reason may be preferred to the pyramid, but, on the other hand, there is reason to suppose that diamond pyramids can be more accurately prepared than diamond cones, which, if correct, is in fair agreement with a standard pyramid test. The standardisation of a comparatively new test has disadvantages, but the question of early initiation of experiments with a view to ultimate standardisation of some form of diamond indentation test appears worthy of consideration.

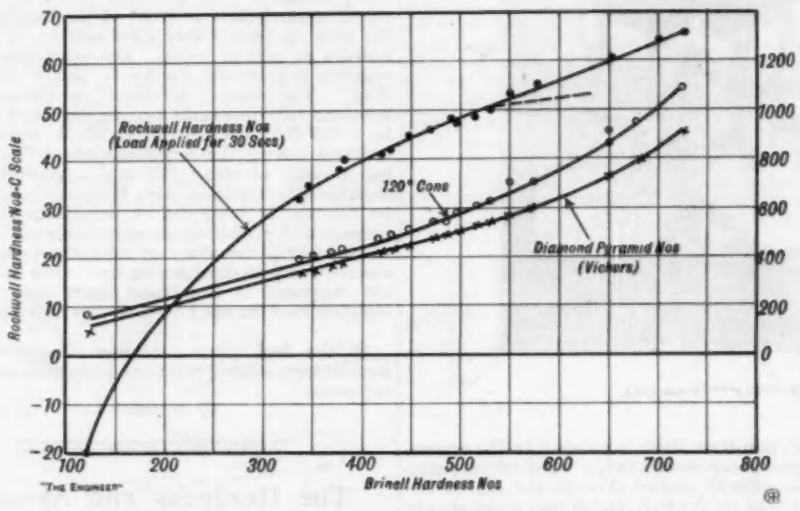


FIG. 1—BRINELL AND ROCKWELL SCALES COMPARED

(*c*) *The Steel Cone Indentation Test.*—Dr. Unwin has remarked that the 90 deg. cone test seems so rational that it is surprising that it has not come into wider use. but at present it is not commercially important in this country. The results obtained in cone tests, however, appear to be worthy of study, since impressions at all loads are geometrically similar for a given cone angle, and the tests are thus less complicated than the ball test. As would be expected, the result of a 90 deg. cone test when expressed as load/area of indentation is independent of the load when diameter measurements are used, and the author has shown that this is true for 45 deg., 60 deg., 90 deg. and 120 deg. cones. Batson has shown that cone results obtained from the depth of the impression decrease with increasing load. Unwin has suggested that cone and ball tests should agree when the results are expressed as $\frac{P}{\pi r^2}$ (P = load, $2r$ = diameter of indentation), but experiment has shown that this is not correct. When certain assumptions are made as to the adhesion or friction between the indenting tool and the material, the author has shown that the adhesion may account for the difference between cone and ball test results. Ludwik has given many results of 90 deg. cone tests, and although conversion of these results to Brinell numbers is not always possible, the experiments of Batson and of the author show that approximate conversions can be made in many cases. Thus, for normal steels of hardness 100 to 300 Brinell number, the following rule would give an approximate value of the Brinell number from 90 deg. cone tests :—

$$\text{Brinell number} = \frac{\text{cone hardness}}{1{\cdot}3}$$

where cone hardness

$$= \frac{\text{load in kilos. (P)}}{\text{projected area of 90 deg. cone indentation in sq. mm. } (\pi r^2)}$$

(*d*) *The Haigh Prism Test.*—This test is essentially a static indentation test in which two similar pieces of the test material are used to deform each other; the method is thus independent of the deformation of any indenting tool. The form recommended for the test-pieces are square prism, *e.g.*, the ends of Izod test-pieces; two such prisms are held crosswise in a jig with their edges in contact and a given load is applied. Provided the indentation is not too large in proportion to the dimensions of the test-piece, its form is independent of the load, and the loads are proportional to the square of a linear dimension of the indentations. Prism hardness is defined therefore as $\frac{P}{x^2}$, where P is the load in tons and x is the width of the indentation in inches from corner to corner along the cutting edge. An interesting point is that the form of the indentation, which varies for different metals, is not related to the actual prism hardness value. The test does not appear to have become popular in laboratory or industrial testing.

(*e*) *The Herbert Pendulum Hardness Tester.*—This instrument consists of an arched casting which is supported on the test specimen on a 1 mm. diameter steel ball or on a ball-shaped diamond. The centre of gravity of the whole can be brought to a predetermined distance below the centre of the ball, and it then constitutes a pendulum. Various tests can be carried out with the instrument, which, however, appears to be more suited to the laboratory than to the workshop. The "time test result" is defined as the time of ten single swings of the pendulum, and appears to give a measure of the size of the indentation produced in the test material; the results are thus related to Brinell numbers. The time result is about seventy seconds for hardened tool-steel, and about twenty seconds for mild steel. The most interesting test appears to be the work-hardening test, and in this application of the instrument the surface of the test material is work-hardened by rolling it with the ball of the pendulum, and time tests are then made. The "induced hardness" is shown by an increase in the result of the time test, and, as would be expected, Hadfield's manganese steel shows a very high induced hardness when compared with other materials. This particular application of the pendulum test appears to be of distinct value and worthy of further study since it gives some measure of a property of materials which is of undoubted importance and on which relatively little information has hitherto been obtained.

Benedicks, Nicolau, and others have published results of investigations carried out with the pendulum, and, in general, the results they have obtained are of a similar nature to those given by the inventor of the instrument. In addition Herbert has carried out an extensive investigation of the effect of work-hardening in cutting operations using the pendulum test. He concludes that the maximum "induced hardness" given by the pendulum is a measure of the principal factor in the machinability of ductile metal, and that "the efficiency of a high-speed cutting tool depends on the hot hardness and can only be obtained by testing it hot." It may here be mentioned that a useful outline of the various methods which are being used to designate machining properties of metals, together with a bibliography, is given by O. W. Boston.[6]

(*f*) *Dynamic Indentation Tests.*—For the purposes of discussion dynamic indentation tests can be conveniently divided into two classes: those in which a given indentation is produced in the test material and then measured or compared in some way, and those in which the height of rebound of a hammer is taken as a measure of the hardness. In the first class can be placed a number of tests such as the Martel test, the Auto Punch, the Brinell Meter, &c., while the Shore Scleroscope is the best known example of the second class.

Laboratory tests of the first class were fully discussed in England in 1918,[7] and valuable information was given in papers published at that time and by Unwin's article and subsequent letters in *Engineering*. Edwards and Willis suggested that the dynamic test could be used as an intrinsic measure of hardness, a claim which could not be established, but the discussion of their paper showed clearly that the correct way in which the results of such tests should be expressed was in the form—

$$\frac{\text{energy absorbed (E)}}{\text{volume of indentation produced (V)}}$$

Martel expressed results of dynamic tests in this way in 1895, and using pyramidal indenters he concluded that $\frac{E}{V}$ for a given material was independent of the elements of the tests within reasonable limits. That is to say, the result was independent of the shape of the indenter, and of the ratio of weight to drop of the hammer or monkey. Batson confirmed this for 5 mm. and 10 mm. diameter steel ball indenters on several materials, and also showed that a 90 deg. steel cone indenter gave results not greatly different from the ball values. The ball result is rather surprising when it is remembered that the static ball test shows marked variations in results for different depths of the ball impressions, but it has been reconfirmed by Wust and Bardenheuer. In addition, it has been shown that to a first approximation, the energy absorbed in a 10 mm. ball dynamic test on a given material is proportional to the fourth power of the diameter of the indentation and to the square of the spherical area of the indentation (Edwards, Wust and Bardenheuer). Later investigators have given results of tests based on the former of these conclusions, but since this method of expressing results is inconsistent with the dimensions of the property measured (*see* Guest [8]) it is not so good as Martel's method, which is dimensionally correct. In general, the published results of dynamic tests suggest that the accuracy obtained is not nearly so high as that obtained in static tests.

Unwin deduced that $\frac{E}{V}$ should be approximately the same as the static Brinell number when the same units

[6] "Trans." Amer. Soc. Steel Treating, 1928, Vol. 13, page 49.
[7] "Proc." I. Mech. E., 1918, Vol. ii., page 493.
[8] "Proc." I. Mech. E., 1918, Vol. ii., page 555.

are used, and experimental results agree in showing that for most materials there is a roughly constant ratio of the static to the dynamic result. The mean value of the ratio, however, appears to depend on unknown factors in the methods of test, since Martel gave it as 1·25, Batson as 1·5 (with certain well-marked exceptions), and Wust and Bardenheuer as 1·8. Edwards suggests that with a 10 mm. diameter ball indenter the formula

$$\text{H (Brinell number, static)} = \frac{7455}{d^3}$$

where d is the diameter in mm. of the indentation made with an impact energy of 63 inch-pound, gives a reliable conversion relationship of dynamic to static ball results, but Ayers, using practically the same energy of blow and apparently similar conditions, found a good linear relationship between H and d. It thus appears from the experimental evidence, that dynamic tests of this type are not likely to give accurate results when tfansformed to the usual static numbers. Consideration of the differences between static and dynamic tests shows that any relationship between the results can only be approximate. It is well known that the time is an important factor in the static test and that the time effect varies with the material. A direct conversion from dynamic to static results requires the change in time of loading from a small fraction of a second to, say, thirty seconds, to have the same proportionate effect on all materials, and this, to say the least, is unlikely to be true. Conversion to static Brinell numbers may be permissible when the impact is made simultaneously on a standard material of known Brinell number and of similar physical characteristics to that under test, but the use of a general conversion factor appears to be unjustified. Dynamic ball tests are popular because of the rapidity with which tests can be made, and because the apparatus required can be small and portable; but when an instrument of this type is being used to obtain results referred to the static scale, it is apparent from the above that particular care is required in the interpretation of the results. Considered as an arbitrary test of the behaviour of material under shock, the dynamic indentation test may be found useful. A particular application occurs in the examination of materials at high temperatures, and it is suggested that dynamic hardness results obtained in high-temperature tests should be directly expressed in the form energy absorbed/volume of indentation, and regarded solely as dynamic tests.

Results given by the type of test discussed above are dependent on the energy absorbed by the material, but in the second class of dynamic tests, namely, the rebound tests, the results are mainly dependent on the energy returned to the hammer after the indentation has been made. This, in a particular way, is a measure of the "hardness" of a material, and the results obtained are extremely useful in commercial testing. From the nature of the test, however, it appears that no exact general relation can exist between the hammer rebound and the standard Brinell number. An excellent discussion of results given by the scleroscope test and their relation to static ball indentation tests and other physical properties was given by Shore, Hadfield and others at the Iron and Steel Institute in 1918.

(*g*) *The Meaning of Indentation Tests.*—In the outline of recent work on indentation tests, no mention has been made of the meaning of the tests, and the question of the definition of hardness has not been discussed. As a rule, the industrial worker is not directly interested in the meaning of the test he is using, but is mainly concerned with the comparison of particular batches of material or methods of heat treatment. The indentation hardness test is well suited in many ways for a commercial comparative test of this nature, and the popularity of the Brinell test, for instance, is an indication that it fulfils an important function in industrial testing. The facility with which tests can be made, however, and the apparent simplicity of the numerical values obtained, should not be allowed to disguise their empirical nature, or the fact that they do not necessarily measure the property desired in the test material.

Whether it will ever be possible for the physicist to give an exact definition of hardness as a physical property appears to be an open question, but as far as the engineer is concerned in dealing with more or less ductile materials, the term hardness usually denotes "resistance to plastic deformation." All indentation tests profess to measure this property, but in spite of the many efforts which have been made to place the test on a more rational basis they still remain empirical determinations of unknown quantities. During the last fifteen years a vast amount of information has been recorded on the peculiarities of various indentation tests, but no general comprehensive theory has been formulated which will explain and perhaps correlate all existing forms of the test. It is suggested that the immediate problem which calls for attention, is not the development of new empirical tests, but that a clearer and fuller understanding of the meaning of tests already in everyday use should be obtained.

Useful information on this subject has recently been given by O'Niell, who has carried out a number of liaison experiments with a view to correlating various forms of the static indentation test. O'Niell, however, made no attempt to discuss his results in terms of the stress-strain curves of the materials considered. In the view of the author, the correlation of indentation tests with complete stress-strain curves appears to be the most likely method by which to obtain a fuller insight into the meaning of the tests. Sir Robert Hadfield, in his Memorandum on Hardness in the 1916 Report of the Committee, stated that "no single value can be assigned to the hardness of a material in this general sense (resistance to deformation); it can only be expressed by a complete stress-strain curve." Guest[9] has given an interesting general discussion of both static and dynamic indentation tests referred to stress-strain diagrams. Ludwik says: "If the tensile test is performed purely for the determination of tensile strength (and not for elastic limit, extension, &c.), then with markedly ductile materals it may be completely replaced by an impression hardness test. By the tensile strength is measured not the real tensile strength (cohesion), but only a mean resistance to deformation, which is therefore similar to the measurement made in the hardness test, which, however, is very much more convenient to perform. In this sense, tensile strength and impression hardness express the same property of the material, so it seems to me that a calculation of the hardness number supplementary to the tensile strength is superfluous. The significance of impression hardness tests lies not in the possibility of calculating from them the tensile strength, but in that they measure in a simple manner the resistance to deformation which the material sets up against a more or less large change of shape. It is a matter of indifference whether this deformation follows from tension, compression or shear, the deformation diagrams are closely related." These three eminent authorities then, have emphasised the importance of the complete stress-strain curves in relation to indentation tests; Ludwik's views are particularly illuminating.

Considering the application of these ideas, it is first necessary to determine the form of the stress-strain curve for a given material without reference to indentation tests. The type of curve used by Stead[10] and shown in Fig. 2

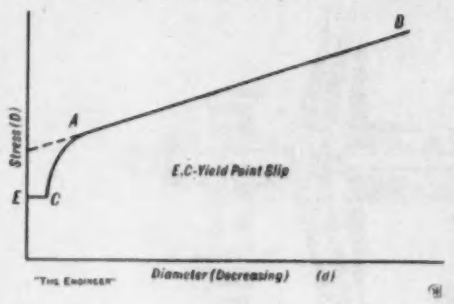


FIG. 2

appears to be suitable, and it is suggested that it may be possible to locate the mean position of particular indentation tests on this curve. For this to be done, the stress and strain in the material immediately in contact with the indenter must be expressed in the same units as those used in the diagram. This is a matter of some difficulty, but rough approximations to the mean positions of particular tests appear to be possible. The known experimental relation between tensile strength and Brinell Number suggests that the normal Brinell test corresponds to the point A of the curve, since this point corresponds approximately to the stress determined in the ordinary tensile test. Relatively deeper ball impressions or small-angle cone impressions, would presumably correspond to a greater strain, while an extremely shallow ball impression would lie on the part E C of the curve. The result of an indentation test is usually expressed in the form load/impressed area, but for stress consideration it should be expressed in the form load/projected area. The mean value then obtained for mild steel in the ball test is of the order of 80 tons per square inch, but this figure gives no direct indication of the stresses in the material, and these must be determined. Until recently, mathematical analysis was of little use in determining stresses in ductile material when the elastic limit had been exceeded, but developments due to Hencky and Prandtl[11] suggest that the stress values in an indentation may be determined approximately. Reference must be made to the original papers for the theory of the methods, but it may be mentioned that by Hencky's method, the mean pressure in a flat circular indentation is about six times the maximum shear stress at which the material is being deformed. In tensile loading the direct stress is twice the maximum shear stress, and accordingly the shear stress at A of Fig. 2 would be about 14 tons per square inch for mild steel. If the mean pressure in the flat circular indentation is of the same order as that obtained in the Brinell test, then the figure of 80 tons per square inch quoted above for mild steel also corresponds roughly to a shear stress of about 14 tons per square inch, and the relation between indentation hardness and tensile strength becomes more intelligible. Again, it is known that the slope of the line A B —Fig. 2—is less for cold-worked materials than for normalised materials, and apparently this behaviour is parallel to the fact that the ball number $\left(\frac{P}{\pi r^2}\right)$ shows less increase with increasing depth, of impression for cold-worked material than for normalised material. Similarly, the stress-strain curve for steel containing a high percentage of manganese is considerably different from that for normal steels, and, of course, it is well known that manganese steel gives abnormal results in ball tests.

Obviously the above remarks can only be considered as preliminary suggestions, but they are put forward with a view to showing that identification of indentation tests with complete stress-strain curves is likely to give valuable information as to the meaning of the tests. During the past five years considerable advances have been made in mathematical methods of attack on the problems of non-elastic deformation of ductile metals, and the study of stresses caused by indentation tests appears to be one direction in which application and development of these methods will be of value.

With regard to the meaning of dynamic indentation tests, little can be said. The energy of the hammer or monkey is used in elastic and non-elastic deformation of the test material, and the energy absorbed by unit volume of material at any given point is given by the area below the stress-strain curve, if the stress and strain are known. Since, however, material further away from the indentation is less deformed than that near the indentation the total energy distribution in any particular form of indentation could only be estimated from the stress-strain curve if the distribution of stress and strain throughout the whole body of the material were known. Further, the stress-strain curve should be the dynamic curve which may be appreciably different from the static curve. Of the energy distribution in the material (neglecting losses in the machine components and in the monkey) part is in the form of elastic deformation and the remainder is used in non-elastic deformation. Only the former is returned to the hammer, and is given as the hardness figure in rebound tests. In the Martel type of test the energy absorbed in the non-elastic deformation is given as the hardness measurement. In an ideal material which is elastic up to a particular stress and then deforms continuously at that stress, Unwin's deduction that energy absorbed/volume of indentation in the dynamic test is equal to load/projected area of indentation in the static test, would appear to be correct for similar indentations.

(To be continued.)

[9] *Loc. cit.*

[10] *Journal*, Iron and Steel Inst., 1923, Vol. cvii., page 377.

[11] Thomas Hawksley Lecture, "Proc." I. Mech. E., 1926, Vol. ii., page 897; see also Sachs, reference 155.

The Sphere of Carbide Tools.*

In appraising such statements as that "the new tungsten carbide cutting tools are destined to revolutionise the machine tool industry," it is well to keep in mind one or two undoubted facts. The first is that revolutions do not occur over night, and the second is that nothing is perfect or universal in application.

Readers of history are liable to have their time-vision greatly foreshortened. For instance, in a few pages, taking less than an hour to read, will be recounted the events which preceded Bunker Hill and the signing of the Declaration of Independence. The American Revolution is so quickly summarised that the reader forgets the seven years of campaigning before victory at arms was won, and the thirty or more years of political consolidation before the United States could certainly be called a nation. We also speak glibly of the revolution in machinery production caused by high-speed steels. We think of it as having occurred rapidly, and speak of it as having been entirely completed. As a matter of fact, Frederick W. Taylor and Maunsel White worked at the problem of lathe tools for twenty-six years. The first tool, heat treated by their method, was publicly exhibited in 1900, and a notable improvement in the metallurgy of high-speed steel was made as late as 1927. Here is a span of half a century since the inception of the idea. The revolution is not yet complete; in fact, high speeds are even now largely confined to mass production.

Such a parallel should not cause one to shut his eyes to those harder tools which cut very much faster; on the other hand, it will indicate that there is no need to throw all the present equipment on the scrap heap before the next inventory. If, in the years since the opening of this century, high-speed tools have not yet been able to eliminate their predecessors, the earlier types must be well enough entrenched to resist inroads from an even more specialised material like tungsten carbide.

These new carbide tools, while wonderful performers in certain *rôles*, have their own limitations. This brings us to our second point—that the new tools are not universal tools, nor are they perfect. They are hard, but they are also brittle; they are so expensive that cutting tips must be brazed or welded to a cheaper steel shank and these joints are not always as good as they might be.

Such facts explain the varying experiences reported to date. Obviously, the new tools are limited to mass production—runs numbered by thousands rather than dozens. Next, they are especially successful on work which high-speed steel has never been able to touch, such as brittle or hard non-metallic materials used in electrical equipment. They also work excellently on the soft, tough alloys of aluminium or copper which dull high-speed steels rapidly. For instance, a tungsten carbide tool turning lynite pistons will hardly ever need sharpening.

In the field of iron and steel there are some definite limitations. As pointed out before, the carbide tools are not adaptable to jobbing work or to short runs, or to work requiring the smoothest finish. Until the tool manufacturing technique is much improved they are limited to tools of simple shape, such as those used on lathes and planers. And here, when working on the harder steels particularly, several experimenters have reported that the shock of entering the cut at rapid feed is sufficient to cause flaking of the tip. Not all tools are alike in this, however. It may well be one of the troubles the manufacturers will be able to solve.

It would appear that tungsten carbide tools are more likely to cause an extension of machine shop work into hitherto unoccupied fields than to cause a rapid revision in the whole tool line-up.

* From the *Iron Age*, June 6th, 1929.

EDUCATIONAL INTELLIGENCE.

The following awards have been made at University College in the Faculty of Engineering:—

Goldsmid Entrance Scholarship: E. A. S. Simonis, University College School.

Jews' Commemoration Scholarship (Additional) (for student of one year's standing, not being Medical, who is most distinguished by general proficiency and good conduct): R. Russell.

L. F. Vernon-Harcourt Prize (Civil and Municipal Engineering): F. Dawson and J. J. O'Donovan (equal).

Chadwick Medal and Prize (Municipal Engineering and Municipal Hygiene): K. G. Shaikh, subject to confirmation by the Chadwick Trustees.

Archibald P. Head Medal and Prize (for the most distinguished Engineering student): R. W. Jaggard.

Diplomas have been awarded to the following:—

Civil and Municipal Engineering: L. F. Amlot, F. Dawson (with distinction), K. Krishna, G. S. Madanpotra, J. J. O'Donovan (with distinction), J. A. Pischaud, K. G. Shaikh (with distinction), D. B. Singh.

Mechanical Engineering: R. W. Jaggard (with distinction).

Electrical Engineering: P. C. Cheryan, J. A. Clegg, A. Ragunather, F. R. Temple (with distinction).

THE ROYAL METAL TRADES PENSION AND BENEVOLENT SOCIETY.—We are informed that the Right Hon. Neville Chamberlain will preside at the eighty-first anniversary festival banquet of this Society, which will be held at the Hotel Victoria, Northumberland-avenue, London, W.C. 2, on Wednesday, December 4th next.

The Royal Agricultural Show at Harrogate.

No. III.*

KERR, STUART AND CO.

ALTHOUGH well known in the railway world, we do not remember this Stoke firm having exhibited on any previous occasion at the Royal Agricultural Show. Quite appropriately, it made its *debut* at Harrogate with an exhibit of real novelty—a Diesel locomotive with an automatic variable-speed friction gear of very ingenious design and excellent construction. There is nothing really new about the engine, which is a 30 horse-power McLaren-Benz, the normal speed of revolution of which is 800 per minute. The power of the engine is transmitted through Robertson gear to a countershaft by a train of helical toothed gearing and thence through a reversing shaft and heavy-pitch roller chain to the front axle of the locomotive, and the two axles are coupled together by means of a second pitch roller chain. A sectional view of the transmission mechanism is given in Fig. 17, while Fig. 18 is a diagrammatic view showing the high and low gears. It will be seen that the drive is taken from the engine fly-wheel through a flexible coupling C attached to the fly-wheel D and a sleeve E that is free to slide on a driving shaft F carrying a cam disc G,

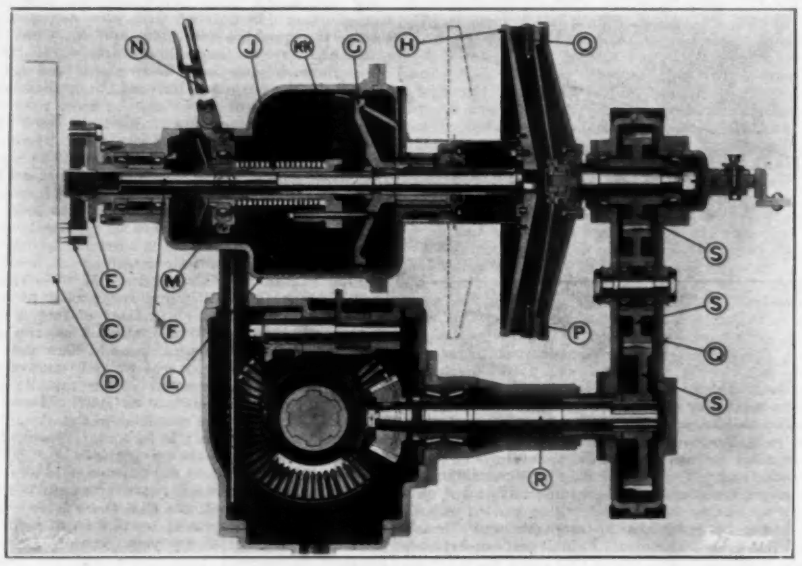


FIG. 17—ROBERTSON AUTOMATIC VARIABLE SPEED GEAR—KERR, STUART

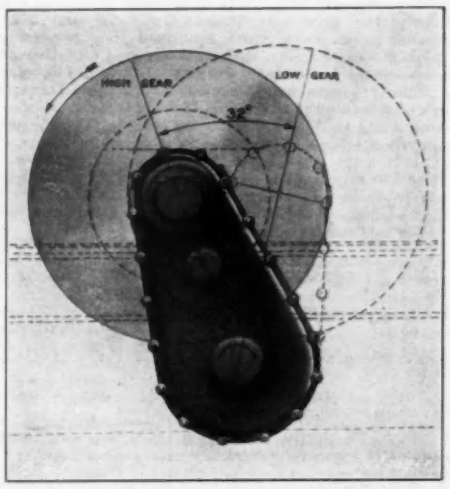


FIG. 18—CASING OF VARIABLE SPEED GEAR

a metal friction cone disc H rotating in ball and roller bearings. A sleeve J splined internally and free to slide on the cam disc shaft, but rotating with it, carries spring-loaded governor weights K K, the whole rotating in an oil-tight case L. A collar M is located on this sleeve by means of a ball bearing and is controlled by a hand lever N. Two annular friction rings O and P are carried at the top end of the gear case Q suspended on a shaft R below the cam disc shaft. This gear case Q, carrying the train of helical gears S which transmits the drive from the cam drive shaft to the countershaft, is free to oscillate about the countershaft in a vertical plane across the face of the friction disc H. Of the two friction rings O is a floating ring and makes contact with the friction disc H, and P is attached to the top shaft of the train of gears. This ring P transmits the drive already picked up by the first friction ring O. Pressure for driving contact between the friction disc and the floating ring is obtained from the centrifugal force generated by the governor weights K resisted by the reaction through gears S.

The action of the gear is as follows:—When the engine is idling and the locomotive stopped, the centrifugal force generated in the governor weights K is insufficient to overcome the spring loading, therefore there is nothing to prevent the cam disc G being drawn back towards the engine fly-wheel D, so that H is entirely out of contact with the friction ring O. By the action of the lever N on the collar M the position of the member carrying the governor weights K is altered, and the reason for this will be seen presently. In the idling position with the locomotive stopped the lever N withdraws the collar M as far towards the engine as it can go, bringing with it the friction disc H and rendering the gear entirely free. The lever N works in a notch plate so that it may be set in a variety of positions, but, when pulled over to bring the collar M as near to the fly-wheel end of the gear as possible, the gear is inoperative even if the engine be speeded up.

On the driver wishing to start, he places the lever N in any one of the graduated notches. This has the effect of moving the collar M away from the engine fly-wheel and bringing the friction cone disc H in close proximity to the floating friction ring O; but as long as the engine is idling the governor weights K K do not swing out, and therefore the cone clutch H does not make actual contact with the friction ring O.

As soon as the driver opens the engine throttle, however, and the engine speeds up, the governor weights K swing out, bringing pressure to bear through the sleeve on to the friction cone disc H, which causes it to press heavily upon the friction ring O. The disc H therefore tries to drive the ring O, but the inertia of the train and locomotive tend to hold the shaft R stationary, and in consequence the helical gears S planet round the shaft R, carrying with them the casing Q and the two friction rings and causing the contact between ring O and disc H to take place on a small diameter of the latter. This has the effect of lowering the gear, and when a sufficiently low ratio has been reached the inertia of the train is overcome and the locomotive moves forward.

As soon, however, as the train gets under way the torque reaction which caused the gear case Q to planet round the shaft R decreases and owing to the angle of the friction ring O, assisted by the speeding up of the engine, and the further swinging out of governor weights K, the friction ring O commences to climb back towards the greatest diameter of the friction disc, thus raising the gear. As more and more speed is got on the train this process continues until, as soon as the train is properly started, the friction ring O comes back to a concentric position with the friction disc H and the whole gear drives as a single-plate clutch. Should now an incline which is beyond the power of the engine on top gear have to be negotiated, the increased torque reaction through the gears S will tend to make the casing Q once more planet round the shaft R and since the lowering of the engine speed, due to the increased demand, will cause the centrifugal force in the governor weights K to diminish, this planetary action will be encouraged and the gear will be lowered until the increase in the engine speed and the lowering of the gear ratio once more call a halt and a balance is re-established.

It will be observed that friction ring O runs quite free on a ball race, and that the drive from it is picked up by the friction ring P. The purpose of this is to enable the friction ring O to turn always irrespective of the amount of power that has to be transmitted; any slip taking place at friction ring P. For this purpose the coefficient of friction of the ring P is lower than that of the ring O, and this absolutely prevents any grooves being ground in the friction ring O. As a matter of fact, when the drive is first taken up the friction ring O runs at a steady speed, driven by friction disc H, and the actual picking up of the drive takes place entirely by means of friction ring P. The reverse gear consists of a dog clutch which engages alternately a right or left-hand bevel gear and the gear is controlled by a separate lever.

DAVEY, PAXMAN AND CO.

An attractive exhibit on this firm's stand was a 120/138 B.H.P. three-cylinder vertical heavy-fuel oil engine—Fig. 19. This engine starts instantly from cold, and is built on the Paxman principle of unit cylinders and ventilated crank cases. The injection of the fuel is on the "spring injection" system, made under licence from the patentees—Blackstone and Co., Ltd.—and the design embodies the Paxman excentric-operated exhaust valve gear. The makers point out that an outstanding feature of these engines is the extreme evenness of the distribution of the fuel to all cylinders, which is obtained by having independent fuel pumps to each cylinder, these fuel pumps and their pipe lines being free from pressure. Other separate parts of the engine were exhibited, including a sectional head completely fitted up with valves, and a cam shaft which can be operated

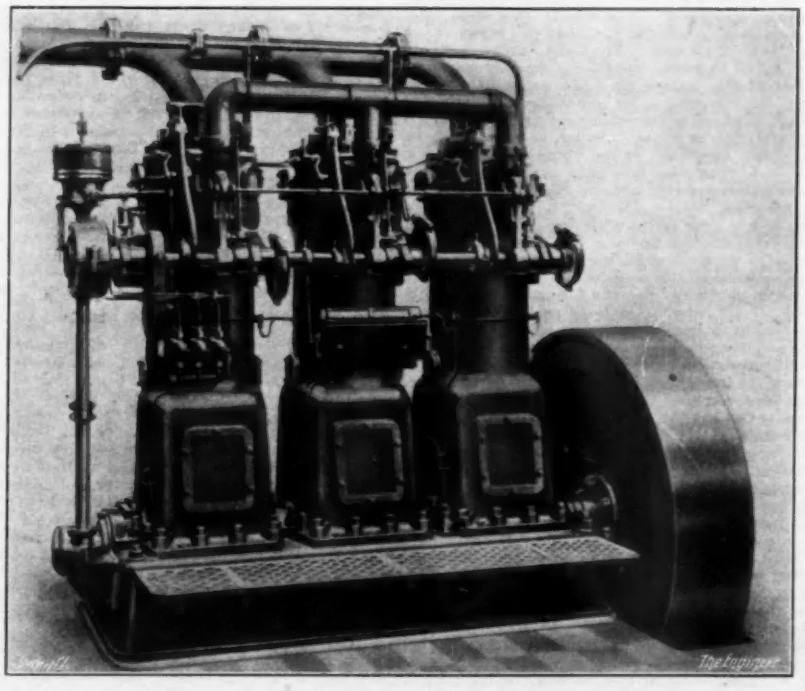


FIG. 19—THREE-CYLINDER HEAVY-OIL ENGINE—PAXMAN

* No. II. appeared July 12th.

by hand to demonstrate its working. We understand that a Paxman eight-cylinder engine of 1070 B.H.P. has been running for some time at the Ashford, Kent, central electricity station, and, owing to its satisfactory working, a further engine, developing 1500 B.H.P., is being supplied, while a similar engine is on order for the Basingstoke Corporation. Both these engines will be fitted with superchargers, and will be the largest airless injection engines yet built in this country for land station work. A model of the Paxman "Economic" type boiler was also on view. It is claimed that this boiler, on account of its large effective heating surface, has an efficiency equal to that of the ordinary Lancashire type boiler nearly double the length and fitted with an economiser.

PETTERS, LTD.

From a wide range of engines shown by Petters, Ltd., Yeovil, we have selected for description the engine. For the small end connecting-rod bearings, rollers are used. These rollers are formed of strip alloy steel of a special kind, heat treated to give maximum toughness and ground to precise limits. By virtue of this construction, it is maintained that the rollers deflect microscopically under shock loads, immediately returning to their normal size and shape upon the load being released, there being no permanent distortion either to themselves or to the surfaces between which they operate. Messrs. Petters' experience is that the use of a complete roller bearing of this type is preferable to a localised form of roller bearing, since, in use, the rollers gradually work round and have several times the wearing surface than the localised form of bearing. This bearing requires very little lubrication. The interior of the cylinders after being bored is honed to dead size in a honing machine, which leaves it absolutely round and obviates wear. The pistons are also ground to size. Every

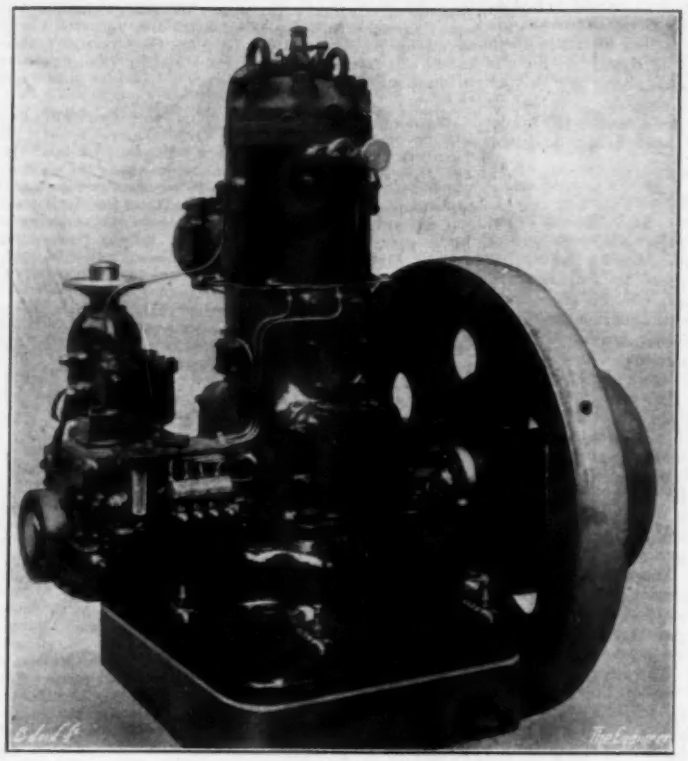


FIG. 20—25 B.H.P HEAVY-OIL ENGINE—PETTERS

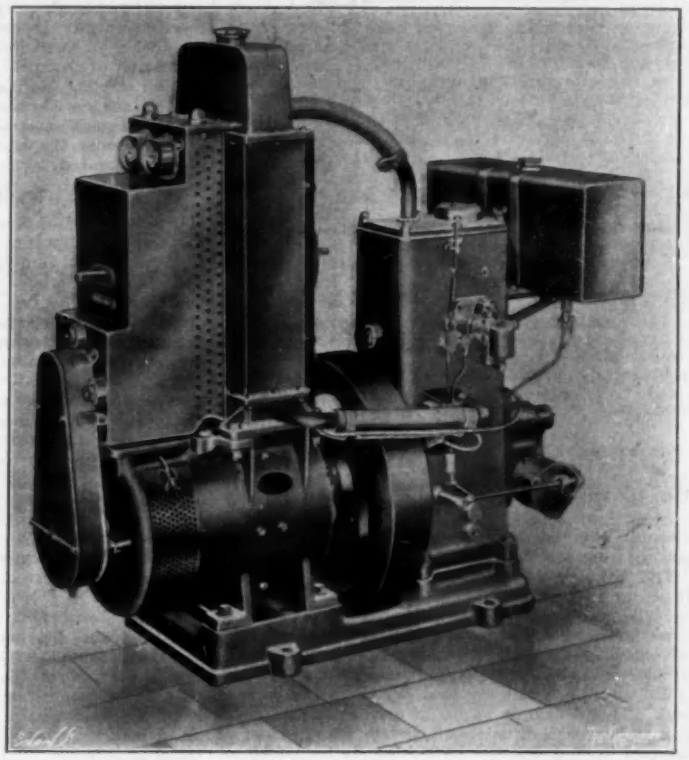


FIG. 21—800-WATT PETROL-ELECTRIC LIGHTING SET—LISTER

25 B.H.P. "atomic" cold-starting, single-cylinder, Diesel engine, and illustrations of this engine are given in Figs. 20, 22, and 23 herewith. It will be noted from the sectional illustration, that the cylinder

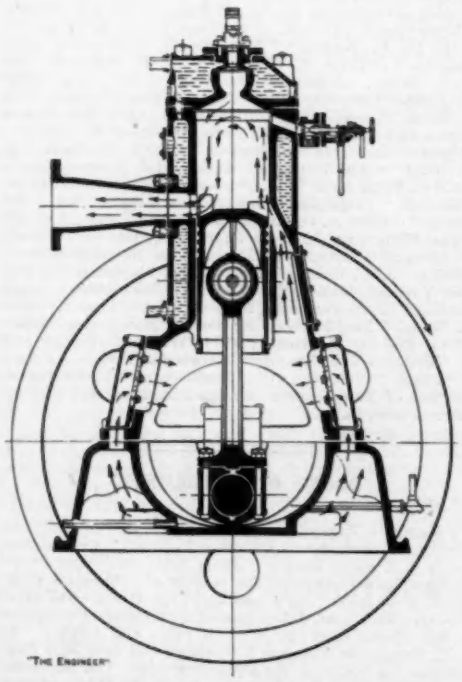


FIG. 22—SECTION THROUGH PETTERS ENGINE

head is of extremely simple design. It is machined all over internally, so as to eliminate excessive gas friction, and the makers claim that that is one of the reasons for the very low consumption of fuel in this type of piston is subjected to special heat treatment after being rough machined, so that all internal stresses may be eliminated and growth prevented.

The fuel oil is injected by the direct action of the fuel pump, without the use of a percussion spring. The use of a percussion spring for fuel injection is, in the makers' opinion, undesirable, as a spring compressed under high pressure and released several hundred times per minute quickly yields to fatigue.

During the latter portion of the compression stroke a considerable degree of turbulence is attained in the combustion chamber, and the fuel oil, which is mechanically injected in the form of a mist or atomised spray of very finely divided particles, meets the turbulent air and produces intimate mixture. Ignition

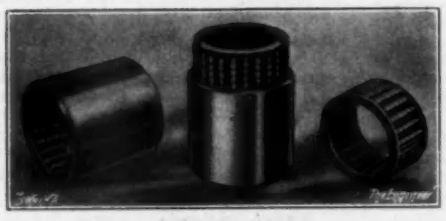


FIG. 23—ROLLER BEARINGS—PETTERS

is caused by the heat generated by the compression pressure. Rapid combustion proceeds over a portion of the working stroke, there being an entire absence of shock, and in that manner high thermal efficiency is secured.

R. A. LISTER AND CO.

The engines shown by R. A. Lister and Co., Ltd., of Dursley, were numerous, and ranged from 1½ to 10 horse-power. The vertical slow-speed engines operate on the four-stroke principle, have automatic lubrication, and are totally enclosed. A special feature of the stand was the compact 800-watt electric lighting set shown in Fig. 21. This plant has been designed to give a steady supply of current at 110 volts without the use of storage batteries. The engine is rated at 2 horse-power, and is water cooled. It operates on the four-stroke principle, and has overhead valves, detachable cylinder head and high-tension magneto ignition. Lubrication is automatic. For starting purposes a combined 12-volt dyna-motor is fitted above the dynamo, the drive being by a roller chain which runs in oil. The engine is fitted with an automatic choke to reduce the air supply to the carburetter, and facilitate starting. The switchboard is mounted above the generator, and carries the volmeter, ammeter and necessary control gear and fuses. There are three control switches to enable the plant to be started and stopped from two points in the house and from the plant house. A 12-volt starting battery of the car type is included in the equipment, and special switchgear is provided to prevent overcharging of the battery by reducing the charging rate as the battery becomes charged. The engine is cooled by means of a radiator and fan. Messrs. Lister also exhibited pumping plants, sheep-shearing and dairy equipments.

BAMFORDS, LTD.

One of the Royal Agricultural Society's Silver Medals was awarded to this Uttoxeter firm for a new vertical four-stroke petrol engine—Fig. 24—in which

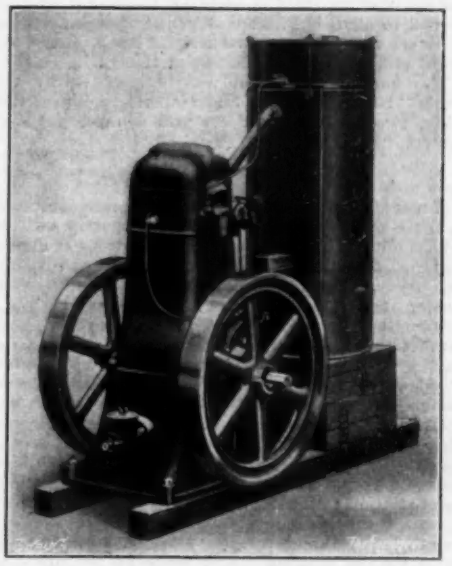


FIG 24—PETROL ENGINE—BAMFORDS

simplicity of design and accessibility of the moving parts are the outstanding features. Although the engine, valves and valve gearing are all totally enclosed, the patented crank case construction is such that all the working parts below the piston can be exposed to view by the removal of four set-screws. The cylinder block is, it may be explained, hinged to

the base. The combustion head is, of semi-hemispherical design—Fig. 25—and is provided with large water spaces for cooling. The vertical exhaust valve is operated by a push rod and rocker arm which also actuate the induction valve. The engine is fitted with a Solex carburetter and Wico high-tension magneto,

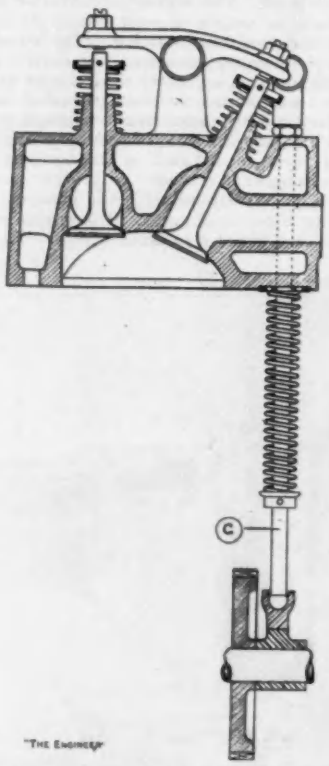


FIG. 25—COMBUSTION HEAD OF BAMFORD ENGINE

operated by an adjustable excentric driven by gearing from the main crank shaft.

The ignition drive which is a patented feature, dispenses with auxiliary gear wheels, chains, sprockets, &c. To economise space, the fuel and cooling tanks have been combined in one unit, the fuel tank surrounding the upper portion of the cooling tank, a circular aperture being left in the centre of the fuel tank, through which to feed water to the cooling tank. This is also an exclusive feature, and in addition to economising space, it assists vaporisation of the fuel in cold weather by raising its temperature. The connecting-rod is of drop forged steel with the big end fitted with adjustable pressure die cast white metal bearing. The main bearings are pressure die cast and adjustable, whilst the crank shaft is drop forged steel, heat treated and ground. The governor is of the sensitive throttle type designed to give a constant uniform speed which is so essential to milking machines, dynamos, &c.

The new engine is being made in stationary or portable models, either tank or hopper cooled, and in sizes 3, 4, and 5 B.H.P. In addition to the new engine, the standard models of horizontal engines from 2 to 10 B.H.P. were shown, but the merits of these are too well known to users in every part of the world and need not be enumerated here.

The harvesting section was represented by the firm's "Royal" mowers and reapers, combined side rakes, swath turners, tedders and windrowers, haymakers, hayloaders, &c.

CITY OF BRADFORD EXHIBIT.

A feature of the implement section of special interest to those engaged in the wool textile industry was the wool trade exhibit organised by the Bradford Technical College. The main section of the display revealed two machines showing wool manipulation in its conversion from fleece to fabric. The first of these is a screw gill box used at three distinct stages in yarn manufacture for blending, opening, and "parallelising" wool fibres. This machine is supplied by Taylor, Wordsworth and Co., Ltd., of Leeds. The second machine is a new type of spinning frame, which has been specially constructed to spin very short wools, such as Cape merinos. The main features of the machine are a creel for twistless rovings, self-weighted back rollers and iron tumblers, and small parchment-covered front rollers. There is a lifter mechanism in which the cam, levers, and ratchet motion co-operate in building up the yarn package suitable either for the twisting operation or for the filling of shuttles in the loom. It is claimed that with this machine short fibres are spun much more economically than has hitherto been possible. A third machine was a sixteen-shaft dobby loom built by Hattersley and Sons, Ltd., of Keighley, which is used for the weaving of artificial silk for dress materials. Special features of interest to engineers include the warp beam adjustment, the automatic shuttle mixing box and the patented clutch drive. Artificial silk is difficult to weave successfully, and this loom represents the latest attempt to enable good results to be achieved.

J. AND H. MCLAREN.

This Leeds firm has for some years devoted much attention to the application of the Diesel engine to heavy agricultural work, such as cable ploughing and cultivating, in addition to the manufacture of steam ploughing machinery, and its exhibits at Harrogate were fully representative of both branches. There were on view McLaren-Benz Diesel engines of 30, 60, and 90 B.H.P., Diesel-electric generating sets, Diesel-engined windlasses for ploughing and cultivating, and a three-furrow subsoil plough of new design. This implement is constructed on the same general lines as the standard balance plough, but has improved mould boards and sub-soiler shares. When in work the whole width of the furrow is cut by the sub-soiler share, and not merely distributed as is usually the case. The soil lifted by the share is allowed to pass over the top of the share, while the top soil is ploughed by a share and mould board of the usual type. In the McLaren-Benz Diesel engine the fuel is injected into the cylinders in liquid form by means of pumps. Air only is drawn in on the suction stroke, and compressed to about 450 lb. per square inch on the compression stroke. Just before the crank shaft reaches the top dead centre, the spray of fuel meets the compressed heated air, and the charge is ignited.

MASSEY-HARRIS.

On the stand of Massey-Harris, Ltd., Bunhill-row, London, E.C. 1, visitors were able to inspect one of those wonderful combination machines for harvesting operations for which agriculturists in this country have little or no use, but which can be effectively operated in countries where the climate is suitable for the complete maturing of standing grain, such, for instance, as Australia and Argentina. The Massey-Harris Company first introduced the stripper-harvester as long ago as 1903. This machine stripped the heads off the standing grain and threshed them in one operation. Later, in 1910, a step forward was made when the same company introduced the reaper-thresher. In this appliance the stripping action was eliminated, and the grain was handled by a reel and cutter bar. On the first reaper-threshers power for operating the mechanism was taken from the main wheel and that restricted the size of the machine to the power of a team of horses. The latest step is the application of the petrol engine to this class of machine. In the new reaper-thresher, after the straw has been cut, the grain is separated from it by a threshing drum, the straw passing over a series of "walkers," which toss it up. The separated grain falls down into troughs from which the grain and chaff are delivered on to sieves for cleaning. The grain makes its way down through the sieves while the chaff is blown out through the rear of the machine. The straw that comes out through the rear of the machine drops down on to revolving beaters, which scatter it over the stubble.

YORKSHIRE STEAM WAGON COMPANY.

Two steam wagons shown on this company's stand are of the firm's most recent design, one being a four-wheeled wagon chassis with hydraulic three-way tipping body, and the other a six-wheeled wagon, both of which have already been described in THE ENGINEER. Since this company commenced operations as long ago as 1902, it has continually adhered to steam as motive power. With the introduction of the rigid six-wheeler, steam vehicles are able to develop their power to the best advantage. At a legal speed limit of 12 miles per hour, steam wagons can carry loads of from 10 to 15 tons, and the makers claim that, on running costs alone, the steam six-wheeler compares favourably with any other form of transport. The principal features of the Yorkshire wagon are a double-ended locomotive type boiler, arranged transversely across the wagon and very accessible; a vertical compound engine and two-speed gear; and in the case of the six-wheeled vehicle, worm gearing and live axle transmission to each rear axle. The steering gear is designed on the Ackerman principle. In the case of the four-wheeled machine power is transmitted to a "dead" rear axle through an intermediate differential gear and twin chains.

(To be continued.)

The Institute of Metals.

THE Autumn Meeting of the Institute of Metals will be held in Düsseldorf from September 9th to 12th, by invitation of the Verein Deutscher Ingenieure and the Deutsche Gesellschaft für Metallkunde. The following programme has been arranged:—

Monday, September 9th.—10 a.m. to 5 p.m.: The office of the honorary local secretary will be open at the Hotel Breidenbacherhof for the issue of tickets, badges, maps, &c., and for general information. 3 p.m.: Members meet at the Hotel Breidenbacherhof to visit the Foundry Trade Exhibition under the guidance of Dr. Nipper. 5 p.m.: eighth Autumn Lecture by Dr. A. G. C. Gwyer, B.Sc., Member of Council, on "Aluminium und seine Legierungen" ("Aluminium and its Alloys"), in German, in the Aula of the Lessing Oberrealschule, Ellerstrasse, Düsseldorf. Evening: Members will be free to make their own arrangements for the evening.

Tuesday, September 10th.—9 a.m. to 1 p.m.: The office will be open as above. 9.30 a.m.: General meeting of members in the Hall of the Eisenhüttenhaus, Verein Deutscher Eisenhüttenleute, 27 Breitestr., Düsseldorf. Welcome by a representative of Verein Deutscher Ingenieure and Deutsche Gesellschaft für Metallkunde. In accordance with the rules, there will be presented a list of members nominated for election on the Council. Papers Nos. 509, 507, 502, 504, (511), (499), (506) will be presented in abstract and discussed as time permits. 10 a.m.: Ladies not attending the general meeting will assemble at the Hotel Breidenbacherhof, afterwards visiting the sights of Düsseldorf by motor omnibus. 12.30 p.m.: The meeting will be adjourned. 1 p.m.: Luncheon, price 3s. 6d. per person, at the Restaurant Salvator. 2.30 p.m.: Visits will be paid to the following (in Düsseldorf):—(*a*) Kaiser-Wilhelm Institut für Eisenforschung (Research Laboratories); (*b*) Foundry Trade Exhibition, the new Beryllium film of Messrs. Siemens und Halske A.G. will be shown; (*c*) Messrs. J. G. Schwietzke (non-ferrous foundry, limited to forty persons); (*d*) Messrs. A. Schmitz (rolling mill works); (*e*) Messrs. August Thyssen-Hütte (steel works). Business competitors are requested not to apply for (*c*), (*d*), and (*e*). 8 p.m.: Members and their ladies will assemble at the Park Hotel by kind invitation of the Lord Mayor of Düsseldorf (Dr. Lehr) for dinner and dancing.

Wednesday, September 11th.—9 a.m. to 1 p.m.: The office will be open as above. 9.30 a.m.: General meeting of members in the Eisenhüttenhaus. Papers Nos. 508, 510, 501, 505, (512), (503), (500) will be presented in abstract and discussed as time permits. 10 a.m.: Ladies not attending the meeting will assemble at the Hotel Breidenbacherhof, afterwards visiting the Castle and Park of Benrath. 12.30 p.m.: The general meeting will be concluded. 1 p.m.: Luncheon, price 3s. 6d. per person, at the Restaurant Salvator. 2.30 p.m.: Visits will be paid to the following (in Duisburg):—(*f*) Messrs. Demag A.G. (makers of mining and metallurgical machinery); (*g*) Messrs. Berg-Heckmann-Selve A.G. Zweigniederlassung C. Heckmann (copper works). Business competitors are requested not to apply for (*f*) and (*g*). Members will travel by motor omnibus, returning in good time for the evening entertainment. 8 p.m.: Carbaret evening in the rooms and garden of the Malkasten, Düsseldorf, to which the Institute's hosts are also invited.

Thursday, September 12th.—8.15 a.m.: Whole-day excursion to Messrs. Krupp, Essen. Members and their ladies will assemble at Hauptbahnhof (Central Station) at 8.15 a.m., and proceed by special train at 8.35 a.m. to Messrs. A. Krupp Steel Works in Essen. Arriving at Essen Hbf. at 9.23 a.m., the ladies will visit, by motor omnibus, the workmen's welfare organisation, workmen's dwellings and works exhibition. Members remain in the train, which will proceed to Essen-Borbeck. Visits will be paid to the new blast-furnaces, Siemens-Martin tilting furnaces, rolling mills for rod, tires and sheet, hydraulic forging presses, foundries and finishing shops. 1.45 p.m.: Luncheon given to members and their ladies by kind invitation of Messrs. Friedrich Krupp A.G., in Hotel Essener Hof. After luncheon ladies will visit the 1929 Flower and Garden Exhibition, Essen ("Gruga"). Members will visit in the afternoon the research laboratories of Messrs. Friedrich Krupp A.G. Arrangements will be made for members proceeding either to Berlin or returning direct to London to do so without returning to Düsseldorf. The party for the excursion to Holland will return to Düsseldorf at 6.30 p.m. and spend the night there.

Friday, September 13th.—Trip to Berlin or Holland.
Saturday, September 14th.—In Berlin or Holland.
Sunday, September 15th.—Return to London.

The following communications are expected to be submitted:—(499) C. O. Bannister, "Studies on the Crystallisation of Gold from the Liquid State"; (500) C. Blazey, "Idiomorphic Crystals of Cuprous Oxide in Copper"; (501) N. F. Budgen, "Pinholes in Aluminium Alloy Castings"; (502) P. Chevenard, A. M. Portevin, and X. F. Waché, "A Dilatometric Study of Some Univariant Two-phase Reactions"; (503) J. Newton Friend, "The Relative Corrodibilities of Ferrous and Non-ferrous Metals and Alloys; Part II., The Results of Seven Years' Exposure to Air at Birmingham"; (504) M. Haas and D. Uno, "An Improved Differential Dilatometer"; (505) O. F. Hudson, T. M. Herbert, F. E. Ball, and E. H. Bucknall, "Properties of Locomotive Fire-box Stays and Plates"; (506) A. Glynne Lobley, "The Creep of 80 : 20 Nickel-Chromium Alloy at High Temperatures"; (507) G. Masing, "Methods of Research in Metallography"; (508) W. J. P. Rohn, "Reduction of Shrinkage Cavities and Vacuum Melting"; (509) W. Rosenhain, "Some Methods of Research in Physical Metallurgy"; (510) M. Tama, "New Methods for Melting Non-ferrous Metals in the Electric Furnace"; (511) W. H. J. Vernon and L. Whitby, "The Open Air Corrosion and Surface Patina of Copper"; (512) A. von Zeerleder and P. Bourgeois, "Effect of Temperature Attained in Overhead Electric Transmission Cables."

BOOKS OF REFERENCE.

"KEMPE'S Engineers' Year Book for 1929." Crosby Lockwood and Son. London, E.C. 4. Crown 8vo. 7 × 5 × 3, limp leather. Price 30s. net.—Once more we have to acknowledge the receipt of "Kempe's Engineers' Year Book," now issued for the thirty-sixth time. The very fact that it has passed successfully through so many editions is evidence of its value and vitality. In the present issue there are 3200 pages and over 3000 illustrations, not counting the advertisements. The particular characteristic of the book is its thoroughly practical character. It is often very convenient to be able to consult an actual drawing of some type of plant that is being considered from the aspect of its utility for a special purpose. This "Kempe" enables one to do. Moreover, it shows him where the plant can be obtained, if he has purchase in view. As a reference book we have found it invaluable ever since its first appearance.

Railway and Road Matters.

THE eleventh session of the International Railway Congress will be held in Madrid from May 5th to the 15th, 1930.

THE three railway unions agreed, in Conference on July 12th, to give the railway companies, three months' notice to terminate the agreement as to the 2½ per cent. reduction in pay.

FROM correspondence published in *The Times* of July 12th as to the 24-hours notation, it appears that the railway companies were willing to adopt it were it done nationally. The Astronomer-Royal says therefore that the Royal Astronomical Society will not proceed further in the matter.

THE London and North-Eastern Company's locomotive accommodation at King's Cross is to be greatly enlarged and improved, in order to provide for the 178 engines, including ten of the "Pacific" class, dealt with there. The additional facilities include a mechanical coaling plant of 500 tons capacity and a 70ft. in place of the present 52ft. turntable.

DURING a debate in the House of Lords on July 11th on the subject of regulating road traffic and increasing the safety and comfort of those who use the highways, Earl Russell, the Parliamentary Secretary to the Ministry of Transport, said that the Royal Commission on Transport would be reporting on certain points at the end of this month (July).

ANSWERING a question on July 9th as to whether the Government was prepared to assist the Southern Railway to extend its electrification into further areas in order to test the benefits of long-distance electrification, Mr. J. H. Thomas replied that the schemes of development and improvement which he had asked the companies to submit, included an extension of electrification.

THE first of three new vessels for the Harwich-Hook of Holland night traffic of the London and North-Eastern Railway was put into service on Monday, July 15th. It has been built by John Brown and Co. Ltd., of Clydebank, and is called the "Vienna." The other two boats are the "Prague" and the "Amsterdam"; both are by the same builders, and are expected to be ready early next year.

A RETIREMENT of note which, though it took place on May 31st, remained unnoticed in the railway Press until mentioned in the *Southern Railway Magazine*, is that of Mr. Surrey Warner, the assistant mechanical engineer at Eastleigh. Mr. Warner received his training under Mr. W. Dean at Swindon, and had been with the Great Western for twenty-eight years when he was made carriage and wagon superintendent to the London and South-Western Railway.

AS the result of three years of experimentation with twelve 65ft. gondola cars in the transportation of long lengths of steel, the Pittsburg and Lake Erie Railroad has ordered 100 additional cars of this type, the first of which are now being delivered. It is stated that the new gondolas effect a material saving in the transportation of lengths of steel too long to be loaded in the standard 46ft. car. Formerly in such cases it was necessary to use two cars, and elaborate blocking was needed to permit the relative motion between cars necessary in train service.

IT was suggested in a question, which the Minister of Transport answered on July 9th, that pressure should be brought to bear to secure the erection of bridges in substitution of level crossings, and that, to avoid long delays pending negotiations between the different interests involved, the allocation of the respective costs of erection to the different interests should be settled in due course, or, if necessary, by arbitration. Mr. Morrison replied that many such schemes had received grants from the Road Fund in recent years, and further proposals were then before him. There were at present no powers for the settlement of differences as to the allocation of costs by arbitration.

THERE is much confusion among railwaymen as to the two terms—trap points and catch points. Trap points are those at the outlet from a siding to the main line or from a goods line to a passenger line, and are intended to prevent, or "trap," such a movement being made without permission. Trap points always face the direction of the movement they are intended to restrain. The term "catch points" applies to the points provided on rising gradients to intercept, or "catch" vehicles that break loose and run back. In fact, it is safe to say that the distinction can always be known by whether the points are to prevent a facing or a trailing movement; the former is a trap and the latter a catch point. Whilst trap points prevent a movement from a goods line to a passenger line, the corresponding points in the line from a passenger road to a goods are catch points, as they intercept an irregular backing movement. The Ministry of Transport requirements for passenger lines strike the happy medium by using in both instances the generic term "safety points."

ACCORDING to the Board of Trade returns the value of the railway material exported during the first five months of the present year was as follows, the corresponding figures for 1928 and 1927 being added in brackets:—Locomotives, £1,292,764 (£1,614,547, £770,161); rails, £1,254,720 (£1,645,332, £892,334); carriages, £824,711 (£1,234,673, £1,246,613); wagons, £1,181,643 (£1,539,655, £852,046); wheels and axles, £183,507 (£416,006, £224,483); tires and axles, £232,950 (£256,895, £204,142); chairs and metal sleepers, £208,918 (£437,269, £432,233); miscellaneous permanent way, £474,054 (£633,633, £612,931); total permanent way, £2,420,516 (£3,455,342, £2,492,931). The weight of the rails exported was 140,623 tons (189,786 tons, 107,221 tons), and of the chairs and metal sleepers, 21,015 tons (44,548 tons, 43,584 tons). During the month of May alone the value of the locomotives sent overseas was £371,081, which included:—India, £175,368; the Argentine, £39,980; Ceylon, £20,990; Strait Settlements, £1473; During the same month rails of the value of £268,171 were shipped, which included the Argentine, £120,651; India, £40,898; South Africa, £38,515; Strait Settlements, £15,842; New Zealand, £10,241; Australia, £5888; and Ceylon, £1098.

Notes and Memoranda.

ACCORDING to the *South African Mining and Engineering Journal*, a crystal of beryl measuring 5ft. by 5ft. by 8ft. 6in. has been excavated from the workings in Namaqualand.

A LIGHTING device operated by the degrees of daylight is to be used on the Grosvenor Canal. The installation consists of flood lighting with a selenium cell device controlled by the intensity of natural light. The lamps light up when daylight diminishes below a certain degree and are automatically extinguished when it rises above that point.

IT is said that an electric shaker conveyor recently set to work by the New Modderfontein Gold Mine is the first of its kind on the Rand. It was supplied by Mavor and Coulson, and is of the type used in British coal pits. The driving motor is of 15 horse-power, and it is capable of delivering from 30 to 35 tons per hour to a distance of 400ft. on the level.

THE number of furnaces in blast at the end of June was 165, an increase of six since the beginning of the month. The production of pig iron in June amounted to 657,800 tons, compared with 654,800 tons in May and 563,700 tons in June, 1928. The production included 207,700 tons of hematite, 277,500 tons of basic, 123,400 tons of foundry, and 23,400 tons of forge pig iron. The June output of steel ingots and castings amounted to 830,900 tons, compared with 843,800 tons in May and 709,000 tons in June, 1928.

AN article in the *Chemical Trade Journal* deals with the equipment of the ss. "Ethyl," which was commissioned by the du Pont Company, of America, to extract bromine from sea water. In conclusion, the author makes the remarks that "altogether it would appear from the results obtained on the ss. 'Ethyl' that the recovery of bromine from sea water is quite feasible by a continuous pipe line process, pumping huge volumes of water through the system at high velocities. There should, therefore, be no reason to fear exhaustion of the world's bromine resources, no matter how great the industrial demand for this element may become, so long as the 'eternal sea' awaits the chemist's demands."

IN concluding an article on "Alcohol in Industry," in *Engineers and Engineering*, Mr. M. C. Whitaker says:—"To sum up the alcohol fuel situation, we feel that the three problems, technical, economic and sociological, stand about as follows. The technical problems have been solved by the chemical and automotive engineers. We can accordingly deposit the 'fuel alcohol baby' upon the doorstep of the economist and social reformer, with full confidence that our obligation has been well performed. There are no technical difficulties remaining, either in the making of an alcohol suitable for fuel blends or in the use of the fuels made therefrom. The problem is now solely one of suitable economic conditions, and one of public will."

IT must be expected that if fuel economisers used for heating feed water are badly arranged, they are liable to serious corrosion on account of the condensation of acid liquid carried by the flue gases; and for this reason the economiser is so arranged that the temperature of the first few rows of tubes never falls below the dew point of the flue gases. A recent official report, however, recounts how an economiser was wrecked by the explosion, brought about by corrosion of a tube near the centre of a nest of twelve rows, while those at the inlet, which were certainly corroded, did not immediately fail. The temperature of the water at the inlet, where it met the incoming flue gases, was, presumably, that of the atmosphere, while its temperature at the outlet was of the order of 220 deg. Fah.

CERTAIN gold-plated "analytical" weights, tested by the United States Bureau of Standards, showed such variations with changes in atmospheric humidity, that the desired certificate could not be granted. These weights were at least seven years old. It thus appears to be definitely established that variability of gold-plated screw-knob weights does not necessarily disappear with age. Moreover, the smaller weights in the set showed a slight gain averaging about 0·1 mg. These changes are quite consistent with the idea that the electro-plating salts that cause this variability are likely to cause permanent gain also. The necessity for exercising great care in the washing that is necessary after weights are plated is again emphasised.

IN his observations on the failure of an auxiliary steam pipe on board a steamer equipped with four boilers, the Engineer Surveyor-in-Chief, Board of Trade, says that it is evident from the auxiliary steam pipe arrangements that the constructors fully appreciated the necessity of providing ample flexibility to meet the effects of expansion, and the vibrations and shocks to which steam pipes on ships are liable, and it must be assumed that it was by oversight so short and rigid a connection was made between the tee piece, which fractured, and the longest and straightest part of the steam pipe range. Cast iron is largely used for tee pieces and other fittings of steam pipes, but it is an unsuitable material for fittings subject, as in this case, to shock and racking stresses. As a matter of fact, the tee piece has been replaced by one of gun-metal, with apparently satisfactory results.

THERE are two expressions of opinion in a recent Board of Trade report on the explosion of a tube in a steam-heated baker's oven. The Engineer Surveyor-in-Chief says that although it was apparently the practice of the makers of these highly-stressed tubes to test hydraulically in the process of manufacture, there was some doubt as to whether the tube which failed had actually been tested. It appears that there was a slight fault in the welding of the tube, which was normally worked at a temperature of 475 deg Fah. The inspector says:—"Although apparently the tube withstood satisfactorily the hydraulic test of 5 tons per square inch stated to have been carried out by the makers, and presumably at a comparatively low temperature, it was not sufficient guarantee that the tube was capable of withstanding a much lower pressure but at a higher temperature. In this instance the expansion by heat of the material in this relatively thick tube and the pressure within it was sufficient so to stress the material at the defective weld that it parted and the tube burst."

Miscellanea.

AN ice rink is to be built in Birmingham, at a cost of £100,000.

A DEPOSIT of soft coal has been discovered near the Tsavyang Gate, Nanking.

IT is announced that the North British Rubber Company has produced a cycle tire inner tube made by the electro-deposition of rubber. One of the claims for the new tube is that, being seamless and having no fibre, there is no tendency for punctures to extend.

WE learn from the *Journal* of the Franklin Institute that the great hole in the earth, known as the Meteor Crater, in Arizona, which is assumed to have been produced by the impact of a meteor, is being mined with the object of disclosing the remains of the meteor itself. The crater itself is 4200ft. in diameter by 600ft. deep, and the meteor has been discovered by means of a bore-hole at a depth of 1400ft.

THE dewatering of the Walwan dam of the Tata Hydro-Electric Company, in India, has, according to *Indian Engineering*, disclosed the fact that the leaks which have developed are not of any great import, and can be closed by pointing. It is noteworthy that the emptying of the lake has not interfered with the supply of power, as the interconnecting with the other plants of the company were able to carry the full load.

PLANS for the improvement of the Soochow Creek as the main waterway for rice transportation in Southern Kiangsu, China, have been formulated jointly by the Special Municipality of Shanghai and the Kiangsu Provincial Government. Surveying of the entire course will shortly be started with a view to widening the creek at various points. The entire river bed will also be dredged so as to provide for the navigation of steam launches.

CONSIDERABLE progress has been made in the Glen Morgan Power Scheme at Ootacamund. Machinery from England has arrived, and it is expected that the plant will be in operation in September. It is understood the local demand for power will not be satisfied by small schemes, and many prospective consumers will have to wait until the construction of a larger one is completed. This is however, still under the consideration of the Government of India.

THE official report to the New York City Board concerning a new vehicular tunnel to connect Staten Island with Brooklyn, advocates one which would be 4700ft. long between pierhead lines. The tunnel would be of the twin type, each tube being about 30ft. in diameter. The length between portals of one tube would be 11,100ft., and that of the other 12,800ft. It is estimated that the cost would be about 80 million dollars, and that the works would require five years for completion.

THE work done by the Engineering Branch of the Agricultural Department of Baroda State is, according to *Indian Engineering*, creditable. Forty-six wells were bored during the past year, of which thirty-six were successful. Thirteen wells were blasted, and in five of them water increased. Demonstrations were given showing the economic use of cartridges compared with ordinary gunpowder for blasting purposes. A portable power pump to check water tapped and test water capacities for installation of water pump was purchased during the year. This will enable the Department to advise well owners more definitely regarding the sufficiency of water supply for power pumping.

MR. JAMES A. BELL, a prominent engineer of St. Thomas, Ont., died on June 25th, at the age of seventy-eight years. Mr. Bell, who was born in Middlesex County, Ont., and graduated as a civil engineer in 1875, had a wide reputation as a bridge and waterworks engineer. He designed and constructed the waterworks of St. Thomas and several other Canadian municipalities, and he supervised the construction of a large portion of the Canada Southern Railway line across Ontario. In 1883 he was Canadian engineer on the cantilever bridge built by the Canada Southern across the Niagara River. For forty-five years he held the position of county engineer for Elgin County, for twenty years was city engineer of St. Thomas, and was a pioneer of the good roads movement.

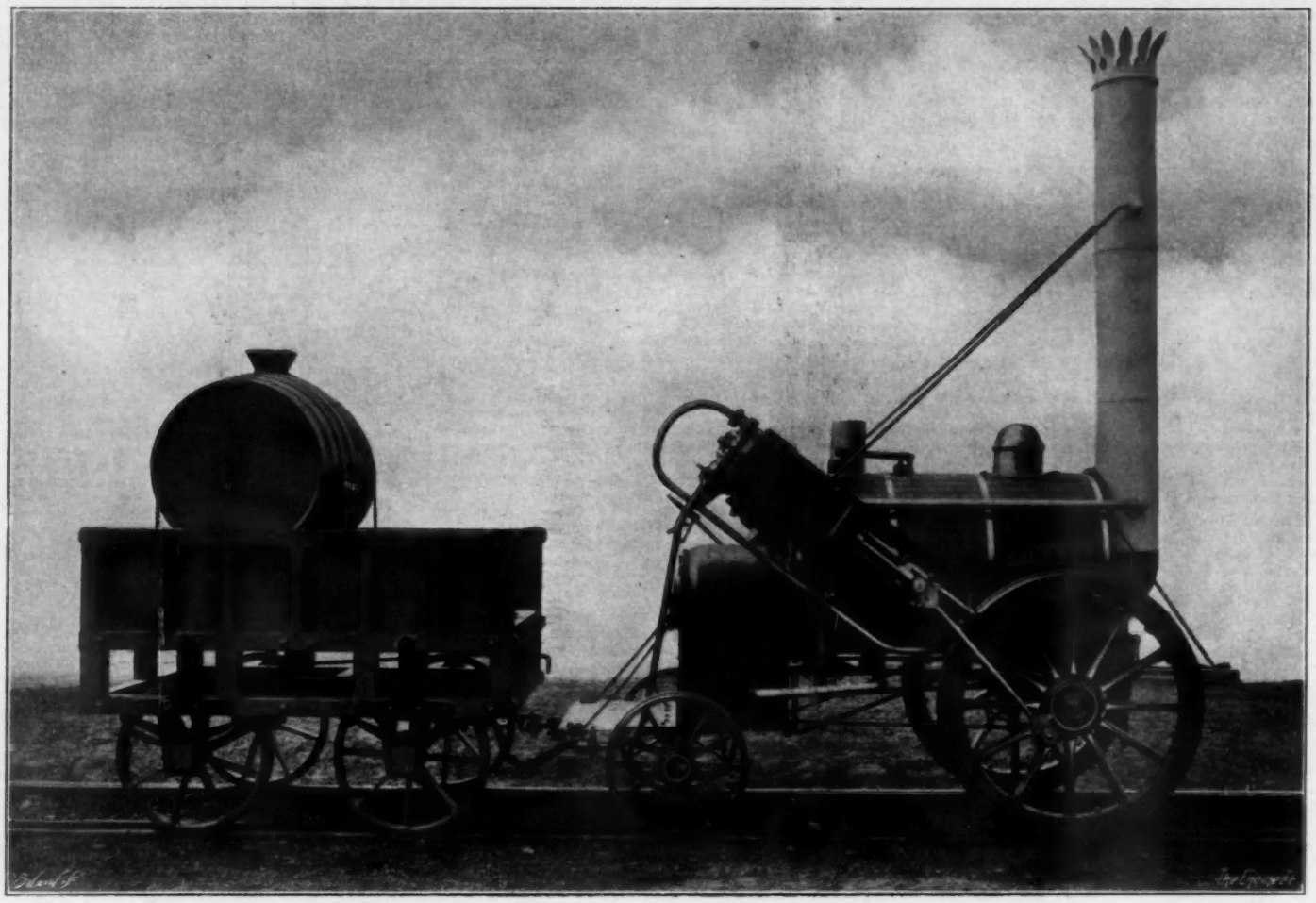
THE Colombian Ministry of Public Works has sanctioned an agreement between the State-owned Ferro-carril-del-Pacifico and a firm of contractors for the extension of the present dock to Sosapenas Island, a distance of 1050 m. The new construction is to accommodate boats of deep draught, and to render possible the reclamation of a large area of marshland on which it is proposed to construct a number of buildings. A project is also under consideration to extend the pier beyond its present length of 393ft. from shore into the estuary, where the water, at present from 18ft. to 20ft. deep at lowest tide, will receive vessels of 24ft. draught. Buenaventura, which is only 210 miles W.S.W. of the capital, Bogota, is the most important Pacific port in Colombia, and the entrepôt for the rich upper basin of the Cauca district, with its two large commercial centres, Popayán and Cali.

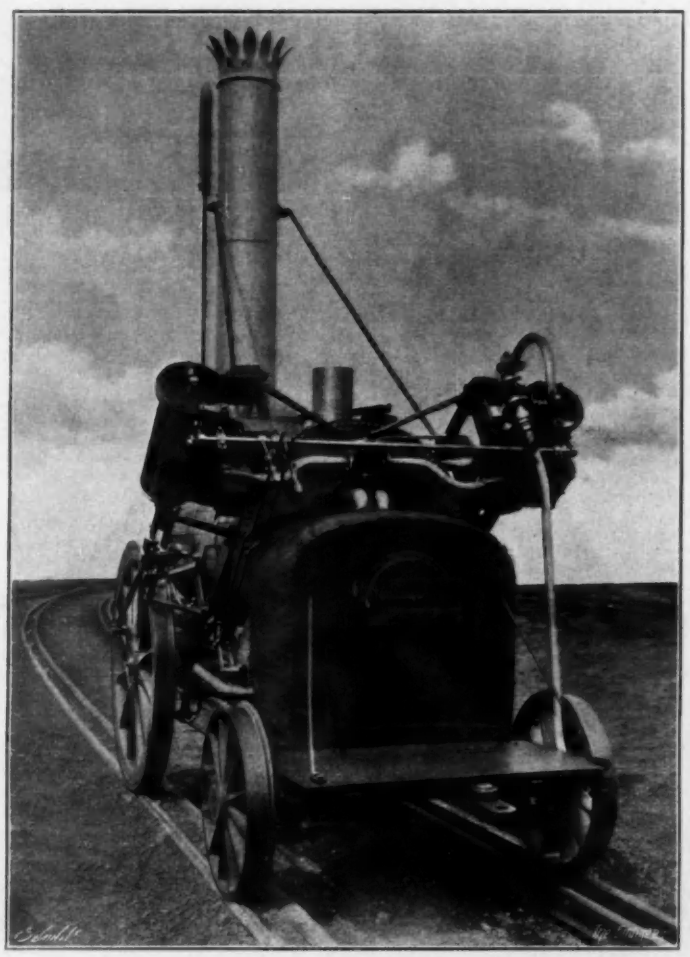
THE latest Irrigation Report of the Madras Presidency contains some interesting details regarding the plant in use at the Mettur project. The power-house contains five oil-driven compressors and two more installed for electric drive have not yet been worked, as there has been delay in the supply of motors. The preliminary crushers have been erected on the right flank, the subsidiary works relating to crushers, *i.e.*, opening and developing quarries are in progress. Electric power from Sivasamudram became available in November last. A new shed for repairs and rolling stock has been erected near the workshops. Liquid oxygen used as an explosive is made in the power-house by the Lightfoot Refrigeration Company. Eighteen "Sentinel" locomotives are in use on the tram line and two more have been ordered, together with 3 cubic yard side-discharge and side-tipping wagons. The 2ft. gauge main line connecting the new railway station and the dam, *via* the new Cauvery bridge, has been finished. Over one crore of rupees is being spent on special machinery. There is scope at the dam for the development of 15,000 H.P. of hydro-electric power.

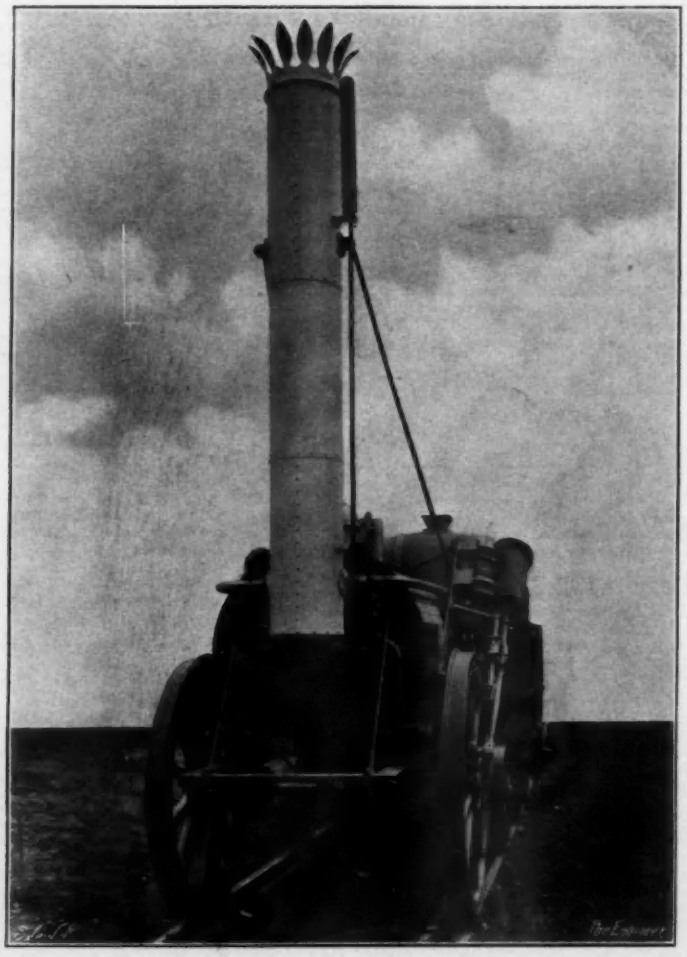
THE REPLICA OF THE "ROCKET"

ROBERT STEPHENSON AND CO., LTD., DARLINGTON, ENGINEERS

(*For description see page 73*)







BRITISH AIRCRAFT AT THE INTERNATIONAL AERONAUTICAL EXHIBITION, OLYMPIA

FIG. I.—TWIN-ENGINED MONOPLANE FLYING BOAT "CUTTY SARK"—S. E. SAUNDERS

FIG. II. TWO-SEATER SUBMARINE SEAPLANE "PETO"—GEO. PARNALL

FIG. III.—ALL-STEEL SINGLE-SEATER FIGHTER "BULLDOG"—BRISTOL AEROPLANE CO.

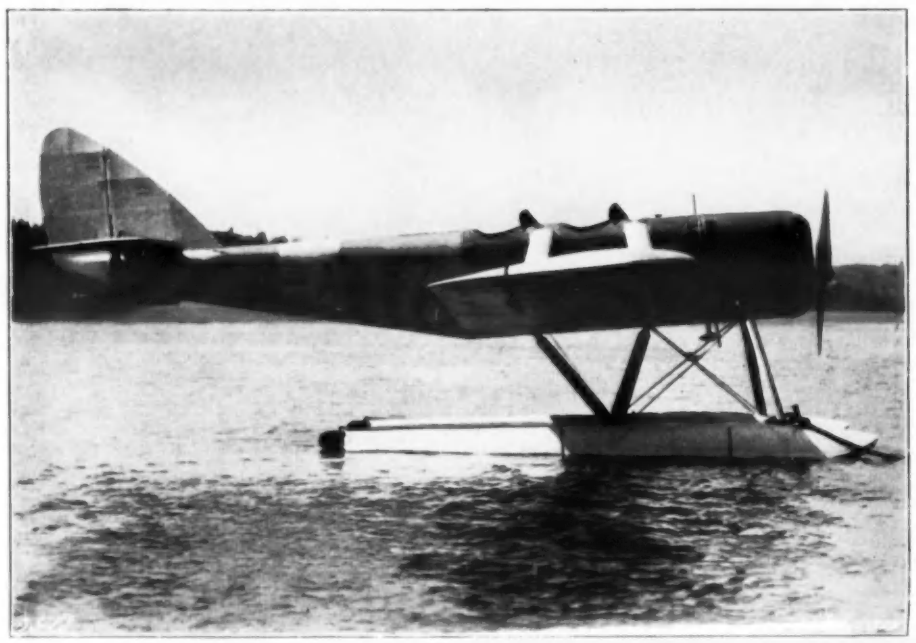


FIG. IV. LIGHT TWO-SEATER SEAPLANE "MUSSEL"—SHORT BROS.

FIG. III.—ALL-STEEL SINGLE-SEATER FIGHTER "BULLDOG"—BRISTOL AEROPLANE CO.

FIG. IV. LIGHT TWO-SEATER SEAPLANE "MUSSEL"—SHORT BROS.

FIG. V.—LONG-RANGE MONOPLANE—FAIREY

FIG. VI.—EIGHT-PASSENGER FOKKER-TYPE MONOPLANE "AVRO TEN"—A. V. ROE

FIG. VII.—HIGH-SPEED DAY BOMBER "HART"—H. G. HAWKER

FIG. VIII.—TWO-SEATER ARMY CO-OPERATION AEROPLANE "ATLAS"—ARMSTRONG WHITWORTH

BMK. OF EDIN.

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THE ENGINEER.

JULY 19, 1929.

The Channel Aeroplane Disaster.

IT is very seldom indeed that the cause of an aeroplane accident can be assigned with such precision and certainty as in the case of the "City of Ottawa," which was lost with seven lives while crossing the Channel on June 17th. In his report to the Secretary of State for Air, Sir Arthur Colefax accepts the technical evidence laid before him that the immediate mishap which brought about the accident was the fracture through fatigue of a pair of studs holding in position the cap of one of the big-end bearings of the starboard engine. In the Napier "Lion" engine, twelve cylinders are arranged in three banks in ⩛ formation, and work on to a four-throw crank shaft. The connecting-rods of the central bank are provided with big-ends which embrace the crank pins. The connecting-rods of the outer banks are coupled to the respective big-ends by wrist pins, so that each big-end bearing has to transmit the forces developed by three cylinders. The cap is attached to the big-end bearing by four studs. After the accident to the "City of Ottawa," it was found that the forward group of three connecting-rods of the starboard engine was completely broken up. It was evident on close inspection that the pair of studs on the port side of the big-end cap had fractured by fatigue, the front stud having failed first, and that subsequently the two studs on the starboard side of the cap had given way. The failure of these studs may be described as the engineering aspect of the disaster. The events which ensued were entirely of an aeronautical order. The engineering failure was not in itself fatal. No one was even hurt when the studs fractured. More than seven minutes elapsed after the failure before the machine struck the water. It is clearly established by the report that the loss of life which attended the accident is attributable to the aeronautical conditions which accompanied or arose from the descent of the machine on to the water. Had the aeronautical conditions been different, the accident might well have had little or no serious effect, either on the passengers or the machine. In calling attention to these two aspects of the disaster, we have no desire to shift the primary blame for it off the engine. There is much requiring earnest attention in both aspects, but they are quite distinct from each other, and should be considered separately.

Considering first the engineering aspect of the accident, we find that the history of the engine which failed is told with some fullness in the report. It was supplied by Messrs. Napier to Imperial Airways sometime apparently in 1925, and was completely overhauled during a period extending from February to the middle of April this year. In the course of this overhaul four new studs for the cap of the big-end bearing which failed were supplied by Messrs. Napier, and fitted in place. It was these particular studs which fractured. The machine with the overhauled engine in place was ready for service on May 30th. It will be gathered therefore that the studs failed by fatigue after the engine had been in service for about a fortnight. The report is unfortunately silent as to the precise number of flying hours which the engine accomplished before the accident. We may, however, take as approximate upper and lower limits three hours per day and three hours every second day. The normal speed of the "Lion" engine is 2350 r.p.m. We may therefore calculate that from the renewal of the studs to the instant of the accident, the engine made a total of from 3,000,000 to 6,000,000 revolutions, the lower figure being probably nearer the mark than the higher. It is an assumption to argue that the stress on the big-end studs passed through one cycle per revolution. We will, however, make it, for the conditions are somewhat too complicated to permit of a ready analysis. It appears, therefore, that after some three or more million reversals or variations of the stress on them, two of the studs failed under fatigue. In fatigue testing, it is quite a common practice to assume that the ability of a specimen to withstand a million reversals or variations of the load is an indication that the applied range of stress is within the limits of safety as regards failure by fatigue. This assumption has been disputed as dangerous, and, if our calculation above can be accepted, it would certainly seem to lend powerful support to those who do not agree with the million-cycle basis in fatigue tests. The Napier "Lion" engine is much too well proved to permit us to regard this accident for a moment as otherwise than quite exceptional. The past history of the design proves beyond a shadow of doubt that the type is not fundamentally open to failure by fatigue at the big-end studs. Assuming, once more, that the steel was of the kind ordinarily employed by the makers, there is no logical way of escaping from the conclusion that the big-end studs of the "City of Ottawa's" engine were under some exceptional conditions as regards fatigue. Even although we take the lower limit of 3,000,000 reversals or variations, it is evident that whatever these exceptional conditions were they exceeded what would have ensured safety from failure by fatigue only by a very small amount. Had the excess been great, failure would have occurred within the first half-hour's service of the engine after the new studs had been put in place. What the slightly excessive conditions were which enabled the studs to withstand three million or more stress cycles before they failed, we cannot definitely state. It is possible, however, to advance a suggestion. The stress on the studs was of a double nature, part being caused by the working forces transmitted to them by the action of the engine, and part being the steady stress produced by the tightness of the nuts. We know that the engine stresses on the studs of the Napier "Lion" are not such as to cause them to fail by fatigue under normal conditions. Is it possible that the additional and indefinite stress produced by the tightness of the nuts in the "City of Ottawa's" engine was originally, or had in use become, sufficiently excessive to raise the total stress above the safety limit ?

The aeronautical aspect of the disaster is of less general interest and significance to the majority of our readers than the engineering aspect. It is, however, of very great importance to all connected with the construction and operation of aircraft. If the recommendations made in the report are given practical effect, it will not be permissible to carry passengers on a journey involving a passage over the sea in any single-engined land type machine. In addition, multiple-engined machines will be allowed to be used for that purpose only if in the event of one engine failing the reserve of power is sufficient to enable them to maintain height. In this connection it seems appropriate to remark that if the second condition is not within

the bounds of what has been attained any time within the past eight or nine years, then the claims made for several types of three-engined machines, and even some twin-engined machines, have been misleading or exaggerated. Since 1920 we have on numerous occasions published descriptions of multiple-engined machines for which the makers claimed that level flight was possible with one engine out of action. At Olympia there is now on exhibition at least one machine which, it is claimed, can not only maintain level flight with one of its two engines idle, but actually can, when fully loaded, climb on one engine to a height of 10,000ft. Whether these claims are exaggerated or not—and we have never had any cause to doubt their veracity—the proposed condition which Sir Arthur Colefax would make an essential requirement for the issue of certificates of airworthiness after July 1st next year only anticipates by a short time what the Imperial Airways' programme would, without the accident and the report, have brought into being. The real aeronautical significance of the disaster lies not so much in these recommendations, as in the desirability which it suggests of devising means to enable land machines to alight in emergency on the sea without doing serious damage to themselves or those they carry. The problem of fitting a flying boat or seaplane with means for alighting safely on land has been solved in the so-called "amphibian." It is surely not impossible to solve the converse problem in a technically and commercially satisfactory manner.

Our Timber Resources.

A LITTLE more than two years ago the Forests Research Board, established in 1921, entered upon its activities at a laboratory at Princes Risborough, which was described in our issue of August 3rd, 1928. It has now issued its first report of its labours. Whilst it would be unfair to expect much after but a few months' work, we must confess that the report is rather disappointing, mainly because, or so it seems to us, too narrow an outlook has been taken. Having personal acquaintance with the vast forests in the Northern Hemisphere, we cannot but feel that the large view was necessary, and we should have been better satisfied had the Board taken a more liberal interpretation of its terms of reference. Great Britain spends about sixty million pounds a year upon imported timber. A greater proportion of that huge sum might be expended within the Empire, and we trust that when the Board has found its feet, it will turn its attention to that matter rather than, as in the present report, contenting itself with the relatively small question of the conversion of British timber into, say, chairs and tables.

England is, of course, one of the finest countries in the world for the growing of hard woods. As good as English oak is not only a romantic phrase; it is a statement of a fact. The oak that made the ships, made England; had we lacked it, we might never have been a great maritime nation with a vast overseas Empire. But hard woods, after all, provide only a comparatively small proportion of the total timber required by the country. In this office there is furniture, made of home-grown timber which has been in service for at least three generations. Outside in the Strand the wooden surface of the road, which has been imported, has been renewed several times within our own memory. Again, pit props for the mines and sleepers for the railways come into Hull by the shipload, but such woods as may take the place of English-grown stuff—the stuff which is used for furniture, coaches, &c.—only occasionally arrive at Tilbury or the London docks. On scanning these two categories of timber imports, it is very noteworthy that practically the whole of those which fall under the general heading of soft woods come from Northern Europe, while the hard woods reach us from our Overseas Dependencies. Nevertheless, it is palpable that Canada is, just now, the world's greatest source of soft woods, a fact which is vouched for by the great amount of United States capital which is being invested in Canadian timber. Yet we still continue to import from Dantzig. On the other hand, our requirements in the way of hard woods are steadily dwindling. Teak decks for ships are rapidly being replaced by those of plain steel, or, where lightness is essential, by pine; houses no longer have oak rafters, they are of steel again; and even furniture for the office is made of steel, instead of the beech of Buckinghamshire. The Princes Risborough establishment seems to us to concentrate on what might be described as these decadent sides of forest products. They are, of course, still important, and there are many parts of industry in which it is difficult to conceive that our various hard woods could be replaced by any other material. On the other hand, the soft wood business continues to grow in importance, but does not seem to receive its meed of attention. Certainly, as it is pointed out in the report of the Board, the commission of the laboratory is to promote the most effective use, not the production, of timber, and it is only natural that a start should be made on the local-grown stuff, but we would like to see greater attention paid to the material which we import, both from our Dominions and from foreign countries. British Columbia, for one, is anxious to supply us with coniferous timber, and is being helped by the two laboratories at Ottawa and Vancouver, but there is still some unaccountable unwillingness on the part of timber users to adopt these Empire woods. It may be, however, that the work of the Forest Products Research Board will help towards the breaking down of this prejudice. In this connection the work of those sections of the laboratory devoted to Timber Mechanics and to Utilisation can give much help. It is satisfactory to find that some investigations have been made into the mechanical strength of Douglas fir, but the trees were home-grown, and there is no assurance that the information gained is applicable to imported timber. Assistance has also been rendered to H.M. Office of Works in the preparation of specifications to allow the substitution of Empire timbers for others that are not of Empire origin, while investigations have been made on timbers from Australia, Rhodesia, and Sierra Leone. Again, in the section devoted to the utilisation of timber attempts are being made to substitute species of home or Empire origin for those imported from foreign countries, with due regard to established trade practices.

The afforestation or reafforestation of Great Britain has long been the aim of reformers, and it is partly to explore the possibilities that the Board was set up. We do not deny the possibility that a much greater proportion of our requirements in soft woods could be grown in this country, but a plantation does not yield a profit until it is forty years old, and another forty must pass before it reaches maturity. Whilst we are waiting, the forest resources of our Overseas Dominions are ripe for the axe. It seems to us that the Board might exercise a more useful function by studying the problems of important soft Empire timbers than by recounting the characteristics of home-grown timbers, which, save for certain experimental woods, are already, through centuries of use, familiar to our workers. However, we have no wish to be hyper-critical of a first report, but we venture to express the hope that when the Board has been in existence for another year or two it will be able to take a broad view of its duties and opportunities.

Obituary.

ALFRED EUGENE MATHEWSON.

IT is with much regret that we have to announce the death on Tuesday last, after a long and trying illness, of Mr. Alfred Eugene Mathewson, chairman and managing director of George Richards and Co., Ltd., and Tilghman's Patent Sand Blast Company, Ltd., Broadheath, near Manchester. Mr. Mathewson was in his fifty-fifth year. He served his apprenticeship with Vickers at Sheffield, and subsequently joined the firm of G. Richards and Co., of which his father, Mr. J. E. Mathewson, was managing director. On the death of his father, Mr. A. E. Mathewson became managing director in his place. During his tenure of that position the establishment at Broadheath was practically doubled in size and its products—machine tools—became known all over the world.

Mr. Mathewson did not associate himself conspicuously with the various engineering societies, but he was a man of sound and original ideas, as was shown by his invention of the chain-driven side planing machine. He was also joint holder of several patents in connection with air compressors which are made by Tilghman's Sand Blast Company, Ltd. He was a shrewd business man, of quiet and unostentatious manner. During the war he worked very hard in conjunction with Sir Alfred Herbert in obtaining the necessary output of shell-making machinery, and for his services was made an Officer of the British Empire.

FREDERICK F. E. JOHNSON.

WE have heard with great regret of the death of Mr. Fredk. F. E. Johnson at his home on Sunday last, after a very brief illness. Mr. Johnson was Executive Officer of the Juvenile Employment Bureau of the Willesden Urban District Council, and was the founder of The Promise Boys' Movement, by which he kept in touch with the numerous boys who passed through his office. He was an enthusiastic worker and published a little periodical called "The Right Start," which was full of matter of interest to boys and their employers. His loss will be very sincerely deplored by hundreds of lads whom he had helped to make a good beginning in industrial careers.

Literature.

Stores Accounts and Stores Control. By J. H. BURTON. Sir Isaac Pitman and Sons, Ltd., London. 1929. Pp. 144. Price 5s. net.

WHEN it is remembered that something of the order of a third of the cost of the average product of an engineering factory is represented by the material used, it is rather strange that in the reorganisation of many concerns scant attention has been paid to the important question of stores accounts, and that comparatively little has been written on modern methods of control. In the book before us we find a very fair and practical attempt to meet this deficiency, the whole being handled in a systematic and comprehensive way.

The author begins by briefly outlining the theory of his subject—Chapter I.—and sets out the principal advantages of a good system of stores accounting, which is a *sine qud non* if accurate cost accounts are desired. We need go no further than the realisation of the manner in which economies may be effected and waste be eliminated to be convinced that attention paid to ensuring a modern organisation of the stores department will be more than justified.

Of all the points considered, that of *personnel*—Chapter II.—has been treated least effectively and far too lightly, for we are given no idea of the position held by individual members of the staff in the general hierarchy of the organisation. It is our opinion that the head of the stores department of an engineering factory, be he called manager or superintendent, should be an engineer, the number of his assistants naturally being largely governed by the size of the undertaking. We suggest that Mr. Burton would do well to insert a "family tree" for a typical concern, thereby indicating the relative importance of the functions and the status of those in charge of stores, &c. We are told that there are different points of view as to whether the storekeeper should be responsible for the stores ledger or not, but we feel that in no circumstances should he have anything to do with this ledger.

The general organisation of the stores is briefly explained—Chapter III.—and we agree that nobody should have access to the stores other than those employed therein. Too often managers, foremen, &c., by virtue of their position, think nothing of trespass, thereby making it virtually impossible legitimately to hold the storekeeper answerable for discrepancies when they occur. The bin card—sometimes known as the tally card—found as near as possible to the actual articles of which it gives account, is very important in a methodical stores, and the author hardly devotes enough space to it, for he might with advantage show how useful it can be, not only in those uses claimed for it by him, but also in connection with ordering to replenish stores, and in stock-taking, too.

In describing the stores ledger—Chapter IV.—Mr. Burton indicates some of the difficulties incident to the arrangement and titles of the account, but does not allude to the advantages that may be derived from having code numbers for the different materials, enabling the ledger sheets to be filed in order of code number. The author favours showing only quantities in the stores ledger, but we consider that there is a great advantage in having values as well, as they can be used for pricing out issues when such are based on "average price," and it is seldom that prices are not known when goods come in, as they are almost invariably ordered on a contract.

Practical problems associated with the stores ledger are succinctly set out—Chapter V.—upon many of which differences of opinion might be advanced, but little would be gained by discussing them, as much must, of necessity, depend upon local conditions. In common with many others, Mr. Burton has a horror of "secret" stocks accumulating, but this can be reduced to a minimum if all returns to stores are made on a stores delivery or return note.

In the section devoted to financial and organisation matters relating to Stores Accounting—Chapter VI.—considerable attention is given to the vexed question of the desirability or otherwise of having a central purchasing department, and the author states that it is necessary in small works. We go further, and affirm that there cannot be real efficiency in any large organisation without centralising all the activities of buying and storing. The geographical lay-out of the works may render departmental or sectional stores desirable, but these should invariably be treated as part of the central stores, under the management of the head of the stores organisation. Chaos will result

if, as is too often the case, local stores come under shop administration, with the result that unduly large stocks are held, the total amount stored in the whole concern being entirely unjustified.

Stocktaking—Chapter VII.—and the difficulties incidental to it, receives very fair treatment, the advantages of continuous stocktaking being clearly shown. There does not appear to be any reference to the value of the comparison of the "remain" on the bin card with the stores ledger, pre-supposing, of course, that the latter is not kept by the storekeeper. This comparison can be made periodically—say, quarterly—and acts as an excellent check on postings. Where any discrepancy cannot be traced to a clerical error, physical stock can be taken. It also minimises the field of investigation when a discrepancy does arise on actual stocktaking.

The method of recording and accounting advocated by the author—Chapter VIII.—seems to meet the requirements admirably, and the general scheme of things is shown graphically in a manner that is very easily followed. Samples of all the appropriate forms are given, and though some might need modification to meet individual requirements, nothing better could be suggested as a working basis.

We are glad that the author has not omitted allusion to audit—Chapter IX.—as although stores records are not the concern of the professional auditor, we fully agree that some system of internal audit is most desirable, not only on account of the value of the check on stock, but also because of the benefit which arises from the moral effect upon the staff by reason of their having to be ready to submit their books and records at a moment's notice.

Nearly a third of the book is occupied with the applications of machinery in stores accounting—Chapter X.—developed in a very useful and instructive manner. In a large engineering factory the cost of a modern system of stores accounts and stores control would be prohibitive without the assistance of highly developed and effective machinery. In a short concluding chapter—XI.—Mr. Burton shows what may be achieved by an efficient system of control, and he by no means exaggerates his case, for it will be to the advantage of office and factory alike.

It was "the absence of a work dealing exclusively with stores accounting" that "led the author to venture to compile a short treatise in the hope that it might serve a useful purpose," and we believe that his hope will be realised.

Handling London's Underground Traffic. By J. P. THOMAS. London's Underground, 55, Broadway, S.W. 1. Price 7s. 6d.

IN the foreword of this book, written by Mr. Frank Pick, the managing director, we read that the book was started for the benefit of the companies' staff with the idea that it would assist them to view their work, as a whole, from the outside as it were. Then it was felt that a still wider audience might be interested, so the book was enlarged and adapted to meet their requirements. We make this quotation in order that it may be clear that though, as we shall show, the present work reveals every detail in the remarkable organisation of the Underground, it is not offered as an advertisement.

A good deal of the success that has come to the companies which form what is known as the "Underground" lies in the organisation of the operating department. It is fitting, therefore, that that subject should be the first to be dealt with by Mr. Thomas. We learn that there is a scheme of cadetships. It originated shortly after the war in order to afford special opportunity for those men in the service who had shown particular aptitude whilst with the Colours, and had proved their fitness for greater responsibility. The scheme, at the same time, was intended to attract to the railway young men of individuality and exceptional qualifications. For all men in the service there are ample opportunities for improvement. There is a training school at Lambeth North Station, which is equipped on a comprehensive scale for tuition in the various phases of railway operation. Whilst we were quite prepared to hear that provision is made for the education of the men in the driving and braking equipment, we did not expect to find that men are taught the operation of the lifts by means of an actual lift. The Underground School of Signalling is another feature mentioned, but to that we have in the past more than once made reference.

Tempting though it may be to deal with the intervening chapters, we must leave them in order to note that on the control of the traffic. Even there we have to resist temptation; it would have been of interest to quote the description given by Mr. Thomas of the simple means thought sufficient in the "steam" days to deal with the causes of delay on the Metropolitan District Railway. Delays to-day are very rare, and there are less than three delays of more than three minutes each per 100,000 car miles run. The number of signal failures is 1 in 213,857 movements. Although the author does not say so, we believe that a failure on the danger side, *e.g.*, a "clear" signal being irregularly given, is very rare indeed. The tunnel telephone whereby a motorman can communicate with the sub-station should his train come to a stand in a tunnel on a tube railway; the emergency cutting out of the current at the sub-station, on the two bare wires in the tube being pinched together; and the brake governor that ensures that unless the brake pressure is up to the required standard the train will not start, are described at length. We learn that the air-controlled doors are very popular with the public.

Other chapters, such as those on the rolling stock, the issue of tickets and the design of stations, are worthy of comment, but we have thought it sufficient to deal with the two most vital—the training of the staff and the control of the trains. Our silence on the other points does not, however, mean that they are of less interest or less worthy of attention. On the contrary, having, as many of our readers will have, a daily contact with the Underground, we naturally take an interest in every one of its various features, all of which are faithfully covered by Mr. Thomas.

It is because of that daily personal touch to which we have just referred that we close this review by quoting what Mr. Pick says in the very first few lines of the book. It is there recorded:—"The organisation and equipment which is clearly and carefully described was not found ready-made. It represents the result of a policy of constant adjustment and improvement spread over some twenty years, in which the author has borne no small or light part. In fact, largely owing to his enterprise and liveliness, the machinery, both human and mechanical, which he describes has been built up."

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Martin Elastic Limit Steel.

By P. G. ROUSE, B.A., M.I.N.A.

THE use of Martinel steel by John Brown and Co., Ltd., for part of the topsides and deck structure of the giant liner "Empress of Britain," which they are building for Canadian Pacific Steamships, Ltd., follows the general adoption of it by Alfred Holt and Co., for the new ships of their fleet. The development of this steel was described in a paper read on March 22nd before the West of Scotland Iron and Steel Institute, Glasgow, by Mr. F. Grimshaw Martin, B.Sc., F.I.C., who some seven years ago began to advocate the heat-treatment of ship steel and the careful measurement of its elastic limit. Previously, shipbuilders and designers had been perforce content to base their calculations on the "yield point," an inexact measurement determined by watching the arm of the testing machine, although it was known that small but measurable amounts of permanent set result from stresses below the yield point. Methods of determining the elastic limit by means of Ewing extensometers are now in commercial use, enabling the designer to base his designs on the elastic limit (or limit of proportionality) instead of on the yield point.

The elastic limit of steel has been found to depend on the arrangement of its micro-structure, and this in ordinary ship steels is affected by the work of rolling the steel and the temperatures at which the rolling is carried out and completed. Martinel steel is a special quality steel subjected after rolling to a special heat treatment which ensures the formation of the micro-structure most favourable to the greatest elastic strength of the steel.

Fig. 1 is from a photo-micrograph (magnification 100)

FIG. 1—ORDINARY MILD STEEL

of ordinary mild steel, of which the elastic limit may vary from as little as, say, 4 tons per square inch up to, say, 14 tons per square inch in exceptional cases; 8/9 tons per square inch is regarded as a not unfair average. The rolled structure caused by rolling can be clearly seen.

Fig. 2 is from a photo-micrograph (magnification 100) of Martinel steel, of which the minimum elastic limit is 15 tons per square inch, and the average about 16·7; figures of 20 tons per square inch have been obtained. The micro-structure is quite different from that of Fig. 1, the heat treatment having removed the effects of rolling.

The ultimate strength of Martinel steel, as now being made, averages about 32 tons per square inch, as compared with about 29 tons per square inch for ordinary mild steel. Its ductility remains high (20/30 per cent.), and it can be worked (punched, sheared, joggled, caulked) as easily as ordinary mild steel.

The heat treatment loosens the mill scale, and this, combined with the extra attention given to the steel in manufacture, gives it a better surface and causes the paint to adhere better. In the paper already referred to Mr. Martin stated that this steel is being used for most of the shell plating, inner bottom, decks, bulkheads, frames, beams, girders, in fact for the entire strength portion of Messrs. Holt's ships. The steel for the "Empress of Britain" is being made by David Colville and Sons, Ltd., Glasgow.

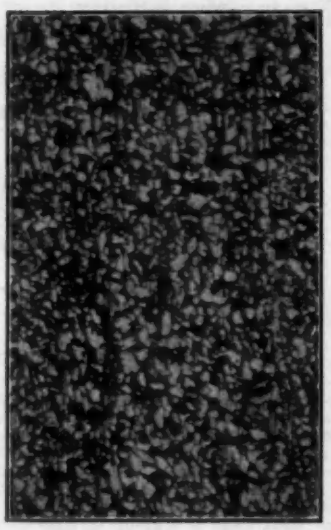


FIG. 2—MARTINEL STEEL

The extra strength of the steel enables the scantlings to be reduced with the approval of the Registration Societies, the actual reduction made varying up to about 12½ per cent., according to the thickness of the material, and the resulting saving of weight can be utilised in various ways so as to compensate for the extra cost of the steel. In the Holt ships extra cargo is carried; in the "Empress of Britain" extra stability will be gained, and, in addition, there will be valuable savings in power and fuel.

High elastic limit steel is being considered by bridge designers for large-span steel bridges, in which the saving of deadweight has a cumulative effect somewhat similar to that in ships, and no doubt other uses will be found. Every improvement in the quality and strength of a material results in unexpected opportunities for its use.

The "Varatio" Variable Speed Gear.

NUMEROUS attempts have been made to devise a satisfactory variable speed gear consisting of a group of gear wheels, tapering in diameter, mounted on one shaft, and a single wheel or pinion which can be slid along the second shaft into gear with one or other of the wheels on the first. In an elementary form this system of speed changing is to be found in certain lathes produced by some of the Yorkshire machine tool makers. In this case the two shafts are parallel. The nest of wheels on the one shaft constitutes a stepped cone. A sliding bracket on the second shaft carries a pinion in driving connection with the second shaft and meshing with an idler which is also mounted on the sliding bracket. Selection of any desired speed is obtained by moving the slider along the second shaft until the idler can be lowered into mesh with the selected wheel of the nest on the first shaft.

In this elementary form the wheels on the first shaft are each of the ordinary parallel toothed spur type and as the teeth of the idler and pinion on the second shaft are of the same form, there is at all settings the usual line contact between the driving and the driven teeth. Now, consider the somewhat obvious development of the elementary form in which the wheels composing the nest are formed, not with the usual parallel teeth, but are in essence a group of bevel wheels which, when assembled on the shaft, constitute a true cone instead of a stepped cone. The accompanying line engraving of the "Varatio" variable speed gear may be referred to as an illustration of this type of speed transmission system in general. Here it may be said that A is the driving shaft and that B, the driven shaft, is coaxial with it, direct contact between the two being established only through a radial ball bearing. The intermediate shaft C lies at an angle to A and B and is driven through a pair of bevel wheels D E fixed to the driving and the intermediate shafts respectively. On the intermediate shaft there is a group of tapered or bevel wheels F—nine in the example illustrated—and the setting of the shaft C is such that the line of the cone constituted by the nest is, at the point of its nearest approach to the shaft B, parallel with that shaft. The immediate advantage which this type of gear, considered in its general form, obtains is the elimination of the idler in the elementary or machine tool type and the avoidance of the consequent clashing engagement which ensues from the dropping, or lifting, of the idler into mesh with the selected wheel of the nest. A single sliding wheel G on the driven shaft will, or so it is intended, when moved axially along that shaft, engage in turn with each of the wheels in the nest F.

The design as we have so far sketched it has appealed to many inventors, but in practice it has in the past met with no great measure of success. Simple as it looks, there are two outstanding difficulties in it which must be overcome if the system is to be successful. In the first place it has to be noticed that if all the wheels of the nest F are in rigid driving connection with the shaft C and if they all have teeth of the same pitch, as they must have if each is to be engageable with the pinion G, then only once in each revolution of the nest will there in general be a clear run through from end to end of the nest for the pinion G. If an attempt were made to change the speed at any time other than when this clear run through presented itself, the pinion G would grind against the face of the wheel it was trying to enter, and when engagement did eventually take place it would certainly not be free from clash. It should also be noted that the ability to change the engagement without risk of damaging the teeth would require the gap between any pair of wheels in the nest to be at least equal to the width of the pinion G, so that the teeth of that pinion might clear the teeth of one wheel of the nest before entering those of the adjacent wheel. If, however, clearance of this amount is provided, then during the act of changing the speed the shaft B must momentarily cease to be driven. In the "Varatio" gear the gap between the teeth of the wheels F is, it will be noticed, less than the width of the pinion G. In spite of this fact the pinion G can, as we shall explain presently, be slid along the shaft B at any point in the revolution of the nest F without noticeable clashing or grinding, without damaging the teeth in any way, and without any detectable interruption in the driving of the shaft B, no matter how slowly the sliding of the pinion G is performed.

The second difficulty which arises in the design of this general type of change speed gear relates to the nature of the contact between the teeth of the pinion G and the teeth of the wheels F. If the teeth of the pinion G are of the usual parallel spur type and if the teeth of the wheels F are cut on the bevel in the ordinary way, then clearly the wheels cannot be engaged to run together. The tapered teeth of the bevel wheels will be too big to enter the parallel gashes of the spur wheel or the parallel teeth of the spur wheel will be too big to enter the tapered gashes of the bevel wheels. To secure a non-locking engagement one or other of four alternatives must be adopted. The parallel gashes in the pinion G must be made of greater width than the teeth of that pinion; or the tapered teeth of the wheels F must be made of less width than the gashes in those wheels; or the teeth of the pinion G must be cut tapered; or the gashes in the wheels F must be cut parallel. In the first two cases the teeth of the pinion and wheels will be in point contact throughout the period of engagement. In the second two cases the engagement will pass through point contact to line contact and then back to point contact as a tooth approaches and recedes from engagement. It is hardly necessary to state that no gear can be perfect or even be a practical success if at any instant the tooth contact is of the point type.

In the "Varatio" change speed gear this difficulty presented by the question of contact is overcome by designing the pinion G in such a way that although it is completely mechanical it behaves as it would do if it were made of rubber. If the pinion were really of rubber and if the conditions were such as to introduce point contact, then under the pressure on the point of contact the tooth of the pinion would deform and the point contact would extend into line contact. The rubber would yield and would maintain line contact throughout the period of engagement, even although the conditions were such as to introduce, in the case of a metal wheel, point contact at the beginning of the tooth engagement, line contact at the middle and point contact again at the end of the engagement.

The fourth alternative mentioned above is adopted. While the pinion G is cut with parallel involute teeth and has its teeth and gashes of equal width as in common practice, the gashes in the wheels F are parallel and are not tapered as in the ordinary form of bevel gear wheel. This expedient by itself is not sufficient, as we have indicated above, to give line contact throughout the whole period of engagement. There will be line contact at the middle of that period, but during the angle of approach there will be point contact at one end of the teeth and during the angle of recess point contact at the other end. These periods of point contact are changed to periods of line contact by the action of the pinion G.

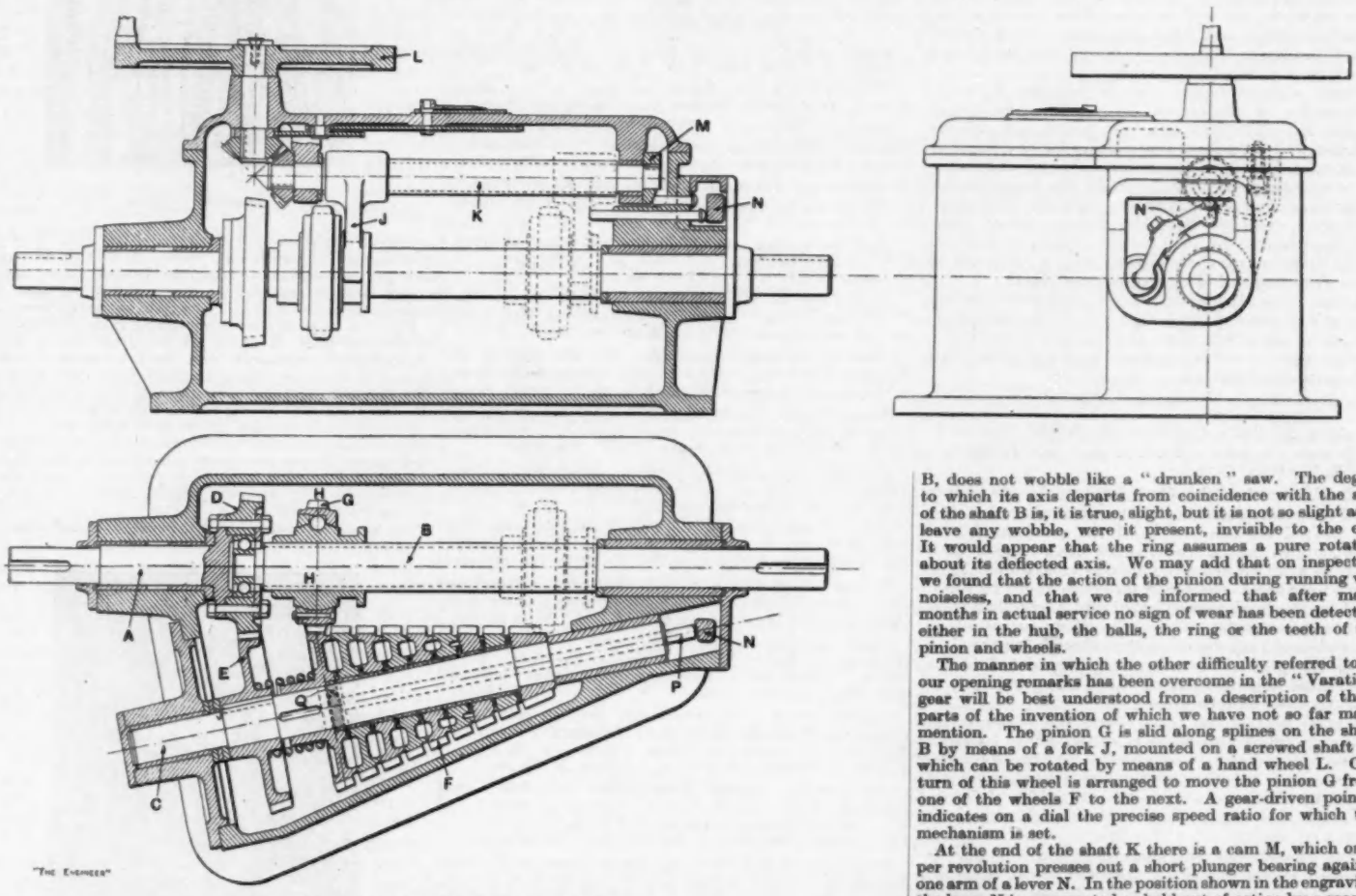
This pinion is built up of two principal parts, an outer ring on which the teeth are cut and an inner hub in driving engagement with the shaft B. A number of hardened steel balls are sunk halfway into the hub, each ball having a hemispherical depression formed in the hub for its reception. The upper half of each ball passes into a flat-ended half hole drilled in the toothed ring from one side. In the 2½ horse-power example illustrated nine balls are provided between the hub and the ring. A cover plate bolted to one face of the ring retains the ring and balls in position on the hub and completes the pinion. The arrangement is such that the balls key the ring to the hub by a binding action which they develop and thereby enable torque to be transmitted from the ring through the hub to the shaft B. The binding action is, however, not effective about an axis at right angles to the torque axis. It leaves the ring free to rotate relatively to the hub about the axis H H. It is perhaps difficult to realise this double effect of the balls from a description and drawing, but the handling of an actual pinion leaves the matter in no doubt. The total movement permitted to the ring about the axis H H is quite small. It is a few degrees only. But it is sufficient to enable the ring to twist the axis about which it rotates out of coincidence with the axis of the shaft B to an extent that will establish at all times line contact between its teeth and the teeth of any one of the wheels F.

It is to be noted that while the gear is running the ring, although in effect it is mounted askew on the shaft B, does not wobble like a "drunken" saw. The degree to which its axis departs from coincidence with the axis of the shaft B is, it is true, slight, but it is not so slight as to leave any wobble, were it present, invisible to the eye. It would appear that the ring assumes a pure rotation about its deflected axis. We may add that on inspection we found that the action of the pinion during running was noiseless, and that we are informed that after many months in actual service no sign of wear has been detected, either in the hub, the balls, the ring or the teeth of the pinion and wheels.

The manner in which the other difficulty referred to in our opening remarks has been overcome in the "Varatio" gear will be best understood from a description of those parts of the invention of which we have not so far made mention. The pinion G is slid along splines on the shaft B by means of a fork J, mounted on a screwed shaft K, which can be rotated by means of a hand wheel L. One turn of this wheel is arranged to move the pinion G from one of the wheels F to the next. A gear-driven pointer indicates on a dial the precise speed ratio for which the mechanism is set.

At the end of the shaft K there is a cam M, which once per revolution presses out a short plunger bearing against one arm of a lever N. In the position shown in the engraving the lever N is represented as held out of action by a second and longer plunger. This second plunger is employed for a special purpose mentioned later. When the lever N is moved by the first plunger its opposite arm forces inwards a rod P, running down the centre of the intermediate shaft C to a key Q, which, passing through a slot in the shaft, engages with the boss of the largest, or ninth, wheel of the nest F. This ninth wheel is driven from the shaft C through a feather on which it can slide, and is acted upon by a spring which forces it towards the right. The remaining members of the nest F are not in direct connection with the shaft C, but are driven from the ninth wheel by means of one-way dog-tooth clutches, formed on the faces of their bosses.

Let it be supposed that it is desired to change gear from the ninth on to the eighth wheel. As the pinion G moves to the right, the rod P forces the ninth wheel to the left against the action of the spring. The dog teeth between the ninth and the eighth wheel open, and all the conical wheels, except the ninth, are, as a consequence, freed from driving connection with the shaft C. The pinion G is still being driven by the ninth wheel. Its farther movement to the right brings its teeth into contact with the teeth of the eighth wheel. If a gap in the eighth wheel is not precisely aligned to receive the teeth of the pinion, there will be a momentary rubbing action between the teeth of the ninth and eighth wheel, which will retard the free-running eighth wheel and the other wheels to the right of it. The retardation required to enable the pinion teeth to pass into mesh with the gaps of the eighth wheel does not exceed one pitch distance, and therefore occurs practically instantaneously. The pinion G is now being driven by the ninth wheel, and is driving the eighth wheel and those to the right. The completion of the movement of the pinion to the right frees its teeth from the ninth wheel. At or immediately after the instant when this freedom occurs the cam M ceases to press on the lever N and, as a result, the spring



THE "VARATIO" VARIABLE SPEED GEAR

behind the ninth wheel moves that wheel over to the right, thereby re-engaging the dog teeth between the ninth and eighth wheels, and re-establishing the driving connection between the shaft C and the eighth wheel and the others to the right of it. The cam M is so shaped and so disposed that at the instant at which the drive from the ninth wheel ceases it is taken up by the eighth wheel. In our presence the handle L was turned as slowly as possible, while the gear was in use transmitting power from an electric motor to a friction brake dynamometer—see the accompanying engraving. If any loss of the drive occurred while the gear ratio was being changed, it was too momentary or too slight to cause even a flicker of the pointers of the dynamometer spring balances. This remark applies to not one, but to all the speed changes and to changes both in the up and down direction.

The action which occurs when the pinion G is moved from the eighth on to the seventh conical wheel—or from one to the other of any subsequent pair—is similar to that described above, although an additional word of explanation may be necessary. The movement of the cam M shifts the ninth wheel to the left as before. For exact similarity it ought to shift the eighth wheel to the left at the same time. The key Q is, however, associated only with the ninth wheel, and therefore there is no direct reason why the eighth wheel should move to the left in company with the ninth. Let it be supposed that the ninth wheel has been moved to the left, and that the eighth has failed to accompany it. The driving connection between the shaft C and the first eight conical wheels has now become interrupted, and under the momentum of the pinion G and of the driven mechanism outside the box the group is free-wheeling on the intermediate shaft substantially as one unit. As the pinion G continues to be moved to the right, the ends of its teeth, either at once or within less time than it takes the group to make one complete revolution, enter the gaps of the seventh wheel. Consider now the action which occurs when the pinion

"VARATIO" GEAR UNDER TEST

teeth are engaged half with the eighth and half with the seventh wheel. The number of teeth on these two wheels is proportional to their mean diameter. There are therefore fewer teeth on the seventh than on the eighth. Both are, however, being driven by the pinion G. Hence, the eighth wheel will run at fewer revolutions per minute than the seventh. The effect of the double engagement is, therefore, to retard the rotary speed of the eighth wheel relatively to that of the seventh. The dog teeth between the two wheels are, however, cut to make the eighth wheel drive the seventh, and are sloped on the non-driving faces. Hence the retardation of the eighth wheel, or, what is the same thing, the relative speeding up of the seventh, causes the sloping faces to engage, and as a consequence the eighth wheel is pushed to the left. The eighth wheel now resumes the drive of the pinion G by virtue of the re-engagement of its dog teeth with those of the ninth wheel. The action is practically instantaneous, and the loss of drive is not detectable. The rest of the process continues as in the case of the change from the ninth to the eighth wheel.

The reverse process, namely, that of changing the speed up the cone instead of down it, need not be described, as the action which occurs should be obvious from what has already been said.

If the pinion G is moved on to the first conical wheel, giving the lowest speed to the driven shaft, and is moved still farther to the right, into the position shown dotted in the line engraving, the fork arm strikes a subsidiary plunger. The movement of this plunger transmitted through the lever N and rod P, declutches the ninth wheel in the usual way and the drive is broken. This neutral condition will persist even although for any reason the rest of the conical wheels Nos. 8 to 2 move along the shaft C into re-engagement with the ninth wheel, for the first wheel, it will be noticed, bears against a collar on the shaft, which prevents its moving with the others. This device is employed not only for throwing the gear into neutral, but for "inching" movements on the lowest speed ratio.

The gear-box illustrated is designed to transmit 2½ H.P., but has actually been tested to handle 10 H.P. for indefinitely long periods. From the highest to the lowest gear, it gives a speed variation of 2·2 to 1. The "Varatio" gear is made by Variable Power Transmissions, Ltd., Britannia Works, Bassein Park-road, Shepherd's Bush, London, W. 12. It is being developed in all sizes to transmit from a fraction of a horse-power up to 1000 H.P., and over. It is proposed to combine the gear with heavy oil engines for locomotive purposes, and is, we understand, already in use or being made for a large variety of other applications. It is claimed to have a very high efficiency, stated to be 95 per cent. or over, and to give a long service life. It is, to our own knowledge, silent while running and while the gear is being changed, and quick and easy to operate. It is possible to run the pinion to and fro from top to bottom of the conical train as quickly as one likes, with very little effort and without any detectable indication of clashing as the speed changes. At the Britannia Works an example of the gear has been in regular workshop use for the past eighteen months, driving an equipment of milling, shaping, cutting-off, and other machines. This box, we are informed, has recently been taken down for examination. It was, we learn, found to be in perfect order and condition, and to require no overhauling or repair.

Report on the 10,500 kW Diesel Generator Set at Hamburg.

IN our issue of June 25th, 1926, we described and illustrated the 15,000 B.H.P. nine-cylinder Diesel engine and 10,500 kW alternator installed in the Neuhof Power Station of the Hamburg Electricity Supply Company, and set to work in September, 1926. According to a recent report on this set, prepared by the M.A.N. Company, which deals more particularly with its working during the year 1928 to 1929, the total capacity of the set, namely, 10,500 kW, is about 20 per cent. of the total capacity of the steam turbine-driven generators, 52,500 kW installed in the Neuhof Station up to the end of 1929.

The average number of working hours of the Diesel set per annum works out at 800 hours. Most of this time the set was utilised to supply peak-load current, but on some occasions the set was employed for base-load service, when the steam sets at one or other of the Hamburg station had to be shut down. In 1928 the time factor of maximum demand for the Diesel set alone based on full load was 320 hours, whereas that for the steam turbine sets alone was 2430 hours, and that for the combined steam turbine and oil engine-driven sets 2055 hours. During the year 1928 the time factor of the steam plant was improved by 375 hours per annum, or nearly 18 per cent. by utilising the oil engine driven peak-load set.

The fuel consumption of the steam sets per unit generated was improved by at least 1000 B.Th.U's, taking a conservative basis for high-class steam turbine generator sets and boilers, with an overall consumption of about 16,000 B.Th.U's per unit and a time factor of 7000 hours per annum, that is at practically constant full load.

Comparing the time factor for all the Hamburg power stations, which was about 3200 hours per annum, with that of the steam plant alone in the same stations, namely, 3520 hours per annum, it will be seen that the time factor of the steam sets was raised by 320 hours per annum, or 10 per cent. of the 3200 hours by the use of a relatively small oil engine driven peak load set working in conjunction with the steam turbine-driven sets. The total power generated by the Diesel set during the peak load hours of 1928 was 3,351,300 units, which total was only 2·75 per cent. of that generated in the Neuhof Station, and only one per cent. of the total power generated during 1928 at all the Hamburg power stations. According to the 1928 effective load diagram for Hamburg, the peak load units generated by the oil engine driven set were only one-fifth of the total peak load, while the maximum load of the set rated at 10,500 kW was only 10 per cent. of the maximum demand of the total system during 1928. During the present year it is expected that the relation between the capacity of the Diesel set and the maximum demand of Hamburg, will be still further reduced as, according to local industrial conditions, a probable rise in the maximum demand of 10 to 15 per cent. may be awaited.

With regard to the general working of the set since it was started up in the autumn of 1926, the management states that it has been found possible to start the engine without the aid of outside current. That is, the engine when run up first of all generated the necessary current for its own auxiliary services, such as scavenge air blowers, lubricating oil and cooling-water pumps, and then supplied current for the auxiliary sets of the steam turbines. When called upon to meet sudden and often unexpected demands, such as a fog or a boiler break down, the set was run up to full load, and in parallel with the remaining steam sets in all cases within a few minutes. All the advantages which were anticipated, when it was decided to install the set, have, it is stated, been completely fulfilled, while the fuel consumption during the past two and a-half years has been well below that guaranteed by the makers. The average consumption of fuel oil per unit generated has not been more than 0·55 lb. of oil, and the costs per peak-load unit are in conformity with the estimated figures. In the opinion of the management the estimated running costs made prior to installing the set were not quite fair to the oil engine driven plant. The expenses for peak-load service only were taken into account, and no allowance was made for the undeniable advantage of having a plant always ready for service at a moment's notice, which plant also constitutes a valuable guarantee to the company's customers in the matter of continuity of supply. It is considered by the management that in the case of such installations some monetary allowance might be made on the cost sheets for these very apparent advantages.

The Quarter's *Shipbuilding* Returns.

FROM the statistics issued by Lloyd's Register of Shipping regarding vessels under construction at the end of June, we note that in Great Britain and Ireland there is an increase of 96,531 tons in the work in hand as compared with the figures for last March, and that the present total—1,453,906 tons—is 251,296 tons greater than the tonnage which was being built at the end of June, 1928. It may be of interest to state that about 66,000 tons of the tonnage now in hand in this country are intended for the British Dominions, and about 208,000 tons are for sale or for foreign shipowners.

The tonnage now under construction abroad—1,384,319 tons—is 96,118 tons less than the work which was in hand at the end of March. Six countries abroad have more than 100,000 tons under construction, viz.:—Germany, 272,444 tons; Japan, 179,968 tons; Holland, 172,406 tons; France, 139,316 tons; Russia, 124,908 tons; and the United States, 119,098 tons. The total tonnage under construction in the world amounts to 2,838,225 tons, of which 51·2 per cent. is being built in Great Britain and Ireland, and 48·8 per cent. abroad; while the average percentages in the last twelve months before the war were 57·2 for Great Britain and Ireland and 42·8 for abroad.

In Great Britain and Ireland 428,400 tons were commenced—an increase of about 66,000 tons over the similar figures for the March quarter; and 392,888 tons were launched—an increase of 103,000 tons. Similar figures for abroad are 270,597 tons commenced, and 321,877 tons launched, the latter figure showing an increase of 50 per cent. on the March total. A slight increase as compared with the previous quarter is shown in the tanker tonnage under construction, the present figures being 49 vessels of 338,774 tons, of which 171,040 tons are being built in Great Britain and Ireland.

While in Great Britain and Ireland the tonnage of motorships under construction—590,429 tons—is much less than the tonnage of steamers being built, the motorship tonnage being constructed abroad reaches 841,791 tons, as compared with 534,166 tons of steamers. The continued progress in the employment of the internal combustion engine for the larger vessels is indicated by the fact that while there are now being built in the world 59 motorships each of 8000 tons and upwards, only 27 steamers of such size are under construction. These figures include 14 motorships and 7 steamers each of 15,000 tons and upwards.

The table respecting marine engines unfortunately does not show complete world figures for marine engines of all types, as the figures for steam turbine engines building in Germany are not available; but the table shows that the indicated horse-power of reciprocating steam engines now being built or fitted on board amounts to 571,000 horse-power, while the figures for oil engines aggregate 1,251,000 horse-power.

The leading position which Lloyd's Register retains amongst the Classification Societies of the world is demonstrated by the fact that the tonnage being constructed throughout the world under the inspection of Lloyd's Register reaches 1,777,011 tons, of which 1,178,998 tons are being built in Great Britain and Ireland.

The Rocket.

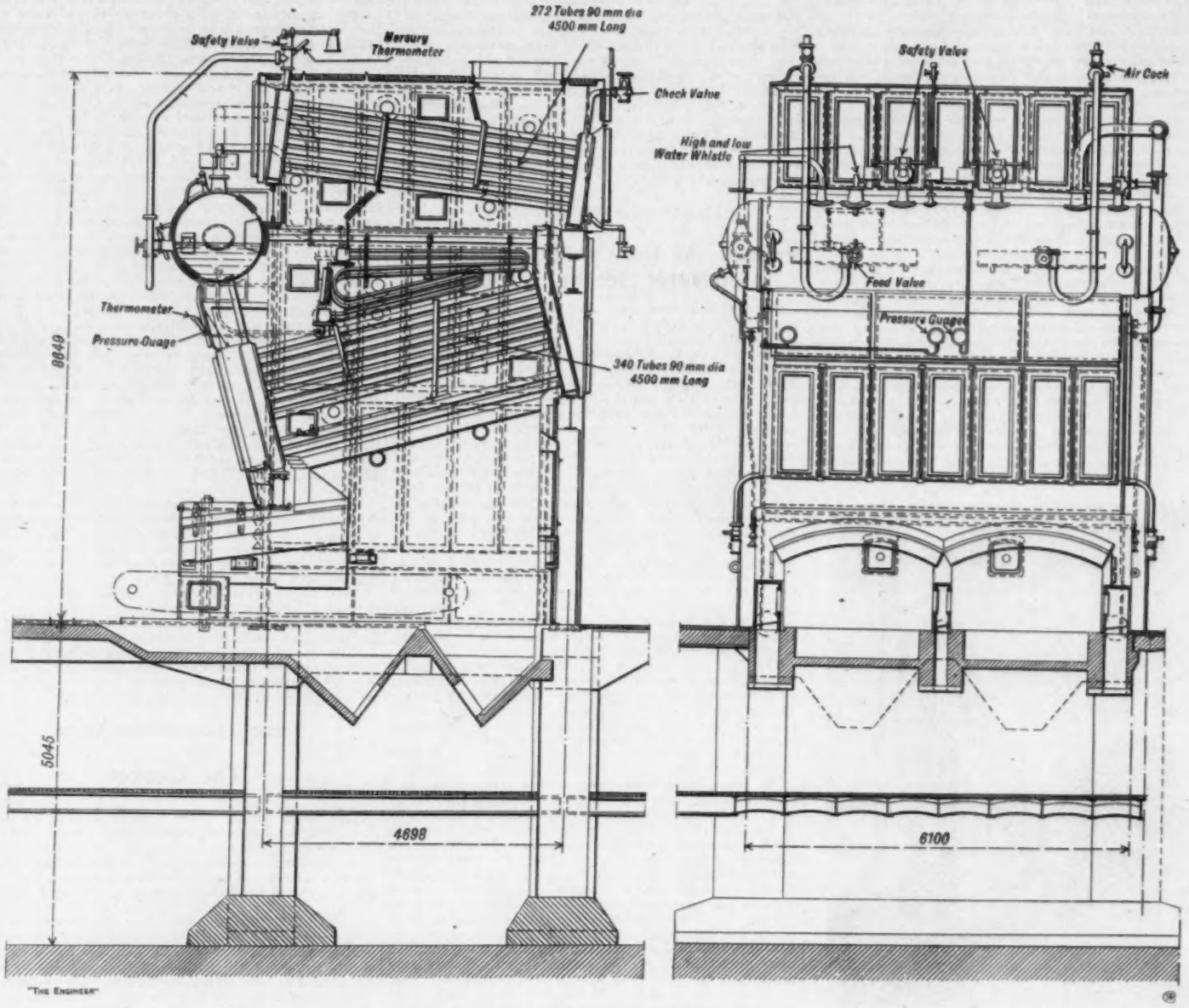
THE perfect replica of the "Rocket," built by Robert Stephenson and Co., Ltd., for Mr. Henry Ford, now forms the feature of greatest interest in the Rainhill exhibit, which has been arranged at the South Kensington Museum. There it now stands beside its old competitors, the "Sans Pareil" and a "colourable imitation" in three-ply wood of the "Novelty." Since the publication of an article on "Rocket II." in our issue of May 31st, Messrs. Stephenson have sent us additional photographs, which we reproduce on page 68. The view from the footplate end shows very clearly the awkward position of the cylinders, to which we alluded in the article referred to. The camera has rather exaggerated the apparent size of the chimney in the front view, but the picture is worth producing as it shows very clearly the position of the exhaust pipes and the form of the mercury pressure gauge.

SIXTY YEARS AGO.

SIXTY years ago the curtain was about to rise on the epilogue of George Hudson's life. This linen draper of York who rose to be "king" of the railway mania of 1845–46—the "big, swollen gambler," as Carlyle called him—was born in 1800. Abandoning his calling for railway promotion, he was elected chairman of the North Midland Company. For three years he was the ruling spirit in the orgy of speculation which attended the development of railways in this country, a development which up to the time of his participation in it had been largely retarded by the opposition of powerful landed interests. He amassed a vast fortune in a short time and was honoured by all classes. He was elected Deputy-Lieutenant for Durham and Lord Mayor of York. When he was chosen to represent Sunderland in the House of Commons in 1845, the occasion was regarded as of such public importance that the news of his election was conveyed to London by a special train which travelled part of the way at least at 75 miles an hour. At the height of his prosperity he was suddenly ruined by the disclosure of the Eastern Railway frauds. His influence and his fortune vanished at once, and those who had believed in his prophecies turned on him in their ruin and savagely reprobated him. The rest of his life was spent mainly abroad in adversity. Towards the end of his life public feeling towards him suffered a change. Men of all classes and parties, remembering the good he had done and forgetting the ruin he had wrought, united to support him in his misfortunes. In our issue of July 16th, 1869, we find it recorded that a meeting had been held at York of subscribers to a fund that had been set on foot to buy him an annuity. The Lord Mayor presided. Mr. J. L. Foster, secretary, reported that from Yorkshire £1280 5s. had been received, and that the total subscriptions amounted to £4400. It was resolved to purchase an annuity for Hudson "in acknowledgment of his services in connection with public works." The amount of the annuity was £512. From vast affluence he fell to dependence on the charity of his friends. He did not live long to enjoy their kindness, for on December 14th, 1871, he died in London, and the drama was played out.

WATER-TUBE BOILER AT THE DROOGENBOSCH POWER STATION

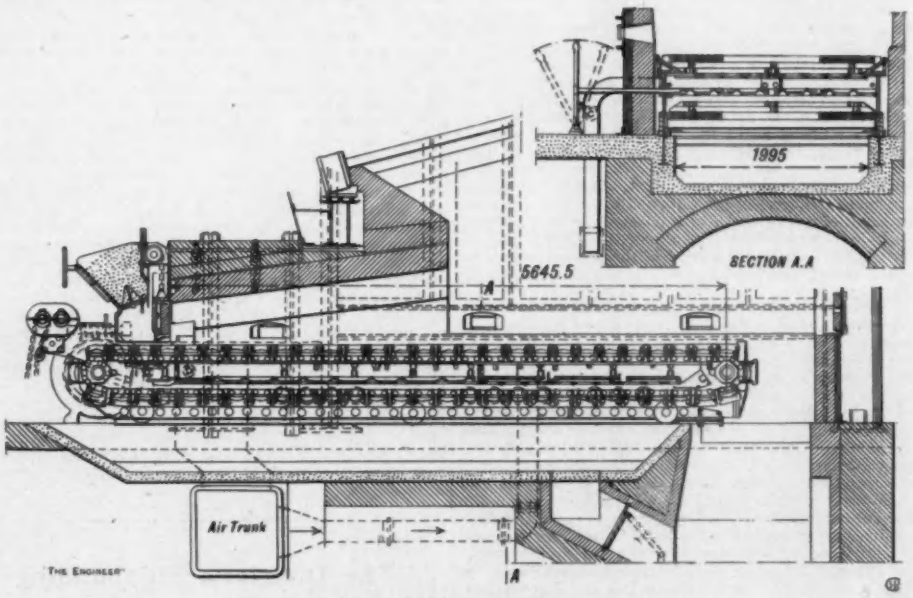
G. BAILLY-MATHOT, CHENEE, NEAR LIEGE, ENGINEERS



Bailly-Mathot Boilers at the Droogenbosch Power Station.

THE Droogenbosch power station, which has recently become a part of the Inter-Brabant electricity supply system, was started in a small way by the Imperial Continental Gas Association in 1910 to supply current to some of the communes surrounding the city of Brussels. Before the war the maximum load on the station never reached 1000 kW, and the whole of the boiler plant consisted of four hand-fired units of the Babcock and Wilcox land type, each with a rated evaporative capacity of only 8600 lb. per hour. While the country was in the hands of the enemy no developments, of course, could be undertaken, but once the invaders were driven out and industrial life could be resumed, an almost continuous series of additions and extensions was begun, bringing the plant up to its present rated capacity of 47,950 kW. The boiler-house now contains sixteen boilers, the last pair to be installed consisting of two units, each rated at 33,000 lb. per hour evaporation, taking the place previously occupied by the four original boilers above referred to. The order for these boilers was placed by the Imperial Continental Gas Association with the firm of G. Bailly-Mathot, of Chênée, near Liége, on the advice of Messrs. Highfield and Roger Smith, who were acting as consulting engineers in connection with the modernisation and extension of the station.

The contract included the supply and erection of the two boilers, with economisers, superheaters, chain grate stokers, forced and induced draught plant, steel chimneys and dust catchers, each boiler unit being separate and complete in itself. The design of the boilers, and that of the stokers is illustrated herewith. The boilers, as will be seen, follow generally the lines of what is known as the cross-drum marine type, but the headers of both boiler and economiser, instead of being sectionalised—as is usual in British practice—take the form of large flat-sided water-boxes. The tube ends are expanded into the adjacent faces of these water-boxes, and a hand hole with cover is provided opposite each tube end. The water-boxes are stiffened by four screwed stays, connecting the front and back faces, around each tube. The design possibly lacks the flexibility of the sectionalised headers, but, on the other hand, it is not without some advantages from the point of view of circulation. In any case, it has been used so largely and for so long in the United States and Canada that its merits are well established, and it has been the standard design of Messrs. Bailly-Mathot for over forty years. The foundation ring of each water-box is an 8in. channel, bent to form, with the flanges inward, the flat steel plates which carry the tubes and the hand holes respectively being riveted to the flanges of the channels. The boiler drums are made with two longitudinal butt-strap joints at opposite ends of a diameter, the plate which is pierced for the tube holes being of greater thickness than the other, except where it is planed down to equal thickness to make the joints. Vertical baffles compel the furnace gases to make three passes across the boiler tubes and three across the economiser tubes before



CHAIN GRATE STOKER

their exit to the chimney, the superheater being placed above the bank of boiler tubes, so that it receives heat from the gases between their first and second pass.

The chain grates, which are of Messrs. Bailly-Mathot's latest type, have many interesting features. Three driving chains passing over sprocket wheels at the front and rear form the foundation for each grate. The three chains are connected by steel cross bars riveted to their links in pairs, each pair of cross bars serving to hold the little fire-bars which form the grate proper. The fire-bed is thus well away from the driving chains, which are not therefore liable to become overheated. Furthermore, the replacement of one or more fire-bars can be effected in a few minutes, without the necessity of taking the boiler off the line. Between the upper and lower parts of the chain is a rectangular wind box of cast iron, which serves not only to support the outward travelling chain, but also provides means for regulating the forced draught in accordance with the needs of the fire. Air from the fans enters the box at the side and escapes through a series of transverse slots in its upper surface. Inside the box, immediately below the top are a pair of sliding plates, which together occupy the full width of the box. These plates are also furnished with slots, so arranged in respect of width and pitch with regard to the slots in the wind box cover, that they can be opened or closed in succession as the slides are moved. Each slide is operated by a lever at the side of the boiler, independently of the other, so that more air can be admitted under either side of the fire at will. At times of heavy load the slides are in such a position that they admit air under the whole length of the fire. As the load falls off, the fire burns back and the end of the grate is thinly covered with ashes only. The slide arrangement then permits of the slots being shut off progressively from the back end of the grate, so that air is only admitted to the furnace where it is needed, and in proportion to the need. There are in all over thirty of these air slots in the length of the grate. The air distribution is thus very uniform, except in so far as it is regulated by the slides in accordance with the requirements of the fire. Leakage of air at the sides of the grate is prevented by the self-adjusting strips which are shown in the cross section. The grates are driven by roller chains from a motor-driven line shaft. The change-speed gear is continuously lubricated, and the final drive is by means of a worm wheel on the front sprocket shaft of the grate. A friction clutch protects the gear from injury should a grate become jammed. No dumping bars are provided, as their function of banking up the ash to prevent excess of air passing through the ends of the grates is needless, owing to the system of forced draught control, while the closed ashpits prevent air entering the furnace at the back.

The principal particulars of each boiler unit are summarised in Table I.

Each boiler unit was guaranteed to be capable of producing normally 33,000 lb. of steam per hour at a pressure of 213 lb. per square inch and a temperature of 698 deg. Fah. from feed water at a temperature of 140 deg. Fah. It was further guaranteed to give an overload of 41,250 lb. of steam per hour for a period of two hours. When burning a mixture of slack coal and fine coke, ranging from 0 to 1¼in. screen, which is the fuel mostly used at Droogenbosch, an overall efficiency of 77 per cent. based on the lower calorific value of the fuel was guaranteed at normal rating. This guarantee was based on the fuel having a gross calorific value of 12,600 B.Th.U. per pound, containing 17·5 per cent. of volatile matter and 16·5 per cent. of ash. A further guarantee was given that the normal load efficiency would be 80 per cent. (L.C.V.) when the boiler was fired with coal having a gross calorific value of 13,500 B.Th.U. per pound with 17·5 per cent. of volatiles and 13 per cent. of ash.

TABLE I.—*Bailly-Mathot Boiler Units at Droogenbosch Power Station.*

Boiler—		
Normal evaporative capacity	15,000 kg. per hour	33,000 lb. per hour
Overload evaporative capacity	18,750 kg. per hour	41,250 lb. per hour
Steam pressure, gauge	15 kg. per cm.²	213 lb. per sq. inch
Steam temperature	370 deg. C.	698 deg. F.
Heating surface	500 sq. m.	5,382 sq. ft.
Number of tubes	340	340
Outside diameter of tubes	90 mm.	3·54in.
Useful length of tubes	4,500 mm.	14·76ft.
Diameter of drum	1,400 mm.	55·12in.
Length of drum	6,460 mm.	21·19ft.
Economiser—		
Heating surface	345 sq. m.	3,713 sq. ft.
Number of tubes	272	272
Outside diameter of tubes	90 mm.	3·54in.
Useful length of tubes	4,500 mm.	14·76ft.
Superheater—		
Heating surface	176 sq. m.	1,894 sq. ft.
Number of tubes	134	134
Outside diameter of tubes	38 mm.	1·5in.
Thickness of tubes	3·5 mm.	0·138in.
Useful length of tubes	11,000 mm.	36·1ft.
Stokers (two per boiler)—		
Useful length of each grate	4,250 mm.	13·8ft.
Useful width of each grate	2,100 mm.	6·9ft.
Total useful surface	17·85 sq. m.	192·1 sq. ft.
Forced draught fan—		
Volume of air delivered per sec.	13·5 cub. m.	477 cub. ft.
Maximum w.g. pressure	70 mm.	2·75in.
Minimum w.g. pressure	40 mm.	1·57in.
Power of motor	30 H.P.	30 H.P.

The boilers were tested on November 6th and the three following days last year, the tests being witnessed throughout by Mr. R. J. Huntley, the chief engineer of the station, on behalf of the purchasers; by Mr Mathot on behalf of the contractors; and by two engineers representing Messrs. Highfield and Roger Smith. Three tests were carried out on each unit, No. 1 boiler doing a six-hour full-load test with mixed fuel, a similar test with coal alone, and a short overload test with mixed fuel. No. 2 boiler was given a six-hour half-load test, a six-hour full-load test, and a two-hour overload test, all with the mixture of coal and coke as fuel. The fuel was weighed in lots of 200 lb. each on the boiler room floor by a direct weighing machine and thrown by hand into the stoker hoppers as required. A sample was taken at the time of each weighing and placed in a box, the quantity thus collected being well mixed at the end of each run and quartered down to obtain final samples for the laboratory. The riddlings were collected at intervals and thrown back into the stoker hoppers, care being taken that they were all burnt at the termination of the run. The ashes formed were collected at the end of each run and weighed. The feed water was supplied by the condensate of one of the turbines. It was delivered into a test tank which had recently been calibrated for an acceptance test of a turbine and was accepted as accurate by the contractors. The water after measurement in this tank was delivered to the boiler by an independent feed pump, the pipe line being isolated from the feed line of the rest of the plant. The flue gases were sampled and analysed every fifteen minutes by the power station chemist with an Orsat apparatus, and temperatures were taken by a calibrated electrical pyrometer. Each boiler had, moreover, a full equipment of its own instruments, including Lea coal meters, steam flow indicators and integrators, &c., which were observed during the trials though their readings were not considered as official. All tests were carried out thoroughly and with great care, the only departure from strict rigidity being in the case of the ninety minutes' overload test on boiler No. 1. For this test, as no efficiency was guaranteed, it was considered sufficient to take readings of the Lea coal meters, previously calibrated by the former six hours' run, as giving the weight of the fuel burnt; also the calorific value of the fuel used on this test was taken to be the same as that for the six-hour test.

Samples of the fuel burnt during each of the remaining five tests were sent to the West Ham Testing Laboratory, London, for proximate analysis, and report on calorific value. Ultimate analyses were also made by the laboratory on one sample of coal and on one sample of the mixed fuel. The results of these analyses are given in Table II., which is a summary of the official record of the trials, with conversion of metric into British units.

It will be noted that the full-load efficiencies obtained when burning the coal and coke mixture were 81·03 per cent. for one boiler and 78·69 per cent. for the other, thus easily exceeding the guarantee of 77 per cent. For the full-load trial on coal alone the recorded efficiency of 83·25 per cent. surpassed the guaranteed figure even more easily. The low percentage of CO_2 in the flue gases indicates an abnormal air leakage into the settings. Had this been discovered and attended to before the tests were begun there can be no doubt that even better results would have been attained.

TABLE II.—*Tests of Bailly-Mathot Boilers at Droogenbosch Power Station.*

	No. 1 boiler.			No. 2 boiler.		
Date of test	6/11/28	6/11/28	9/11/28	7/11/28	8/11/28	8/11/28
Test number	1	2	6	3	4	5
Nature of test	Full load	Overload	Full load	Half load	Full load	Overload
Duration of test, hours	6	1·5	6	6	6	2
Nature of fuel	Coal & coke	Coal & coke	Coal	Coal & coke	Coal & coke	Coal & coke
Ultimate analysis of fuel as fired—						
Carbon, per cent.	65·65	—	73·73	—	—	—
Hydrogen, per cent.	3·18	—	4·15	—	—	—
Oxygen, per cent.	2·61	—	3·29	—	—	—
Nitrogen, per cent.	0·89	—	0·88	—	—	—
Combustible sulphur, per cent.	0·73	—	0·65	—	—	—
Incombustible sulphur, per cent.	0·08	—	0·05	—	—	—
Ash, per cent.	13·71	—	10·40	—	—	—
Moisture, per cent.	13·15	—	6·85	—	—	—
Total	100·00		100·00			
Proximate analysis of fuel as fired—						
Volatile matter, per cent.	15·67	15·67	16·34	15·04	16·24	15·35
Ash, per cent.	13·79	13·79	10·45	14·79	14·00	12·51
Fixed carbon, per cent.	57·39	57·39	66·38	56·95	57·26	59·61
Moisture, per cent.	13·15	13·15	6·85	13·22	12·50	12·53
Total	100·00	100·00	100·00	100·00	100·00	100·00
Calorific value, gross, fuel as fired, B.Th.U. per lb.	10,680	10,680	12,890	10,510	10,860	10,920
Calorific value, net, fuel as fired, B.Th.U. per lb.	10,270	10,270	12,470	10,100	10,460	10,550
Weight of fuel fired per hour, lb.	5,570	6,723	4,345	2,695	5,445	6,336
Average thickness of fire, inches	4	4·75	3·1	3·5	4	4·9
Total weight of ash and clinker, lb.	4,334	Not taken	3,058	2,462	5,060	2,156
Weight of refuse to fuel fired, per cent.	13·0	Not taken	11·7	15·2	15·5	17·0
Average steam pressure (gauge), lb. per sq. in.	212	213·5	211	205	208	213·5
Average total steam temperature, deg. Fah.	703·4	711·5	707	615·2	687·2	692·6
Average temperature of water entering economiser, deg. F.	90·5	90·5	86·0	88·7	88·7	93·2
Average temperature of water leaving economiser, deg. F.	222·8	230·0	206·6	240·8	224·6	206·6
Weight of water evaporated per hour, lb.	35,455	40,779	34,316	17,433	34,450	42,112
Average draught at base of stack, inches W.G.	1·16	1·22	1·02	0·5	1·09	1·06
Average forced draught under grates, inches W.G.	2·52	3·19	1·57	0·74	2·5	3·15
Average draught in furnace, inches W.G.	0·118	0·13	·045	·055	·096	·053
Average temperature on firing floor, deg. Fah.	45·5	45·5	39·2	42·8	39·5	40·0
Average temperature in furnace, deg. Fah.	2,640	2,640	2,720	2,460	2,670	2,710
Average flue gas temperature entering superheater, deg. F.	892	1,036	950	754	977	1,058
Average flue gas temperature leaving superheater, deg. F.	550	588	601	550	652	685
Average flue gas temperature entering economiser, deg. F.	520	547	532	444	527	552
Average flue gas temperature leaving economiser, deg. F.	360	381	366	302	372	383
Flue gas analyses—						
Carbonic acid CO_2 at stack, per cent.	8·30	8·60	8·58	4·60	7·31	9·76
Carbonic oxide CO at stack, per cent.	0·02	0·00	0·00	0·00	0·00	0·28
Oxygen O_2 at stack, per cent.	12·06	11·65	11·36	15·50	12·74	10·06
Nitrogen N_2 at stack, per cent.	79·62	79·75	80·08	79·90	79·95	79·90
Heat account (based on L.C.V. as fired)—						
Heat to boiler, per cent.	62·55	59·20	65·00	63·41	60·89	64·56
Heat to superheater, per cent.	10·29	10·05	10·65	7·91	9·57	10·09
Heat to economiser, per cent.	8·19	8·25	7·60	9·72	8·24	7·14
Gross overall thermal efficiency, per cent.	81·03	77·50	83·25	81·04	78·69	81·79
Heat lost in chimney gases, per cent.	14·67	22·50	13·84	18·96	21·31	18·21
Heat lost in ash, radiation, &c., per cent.	4·30		2·91			

Letters to the Editor.

(*We do not hold ourselves responsible for the opinions of our correspondents.*)

CASCADE TUNNEL.

SIR,—The description of this work in your issue of July 5th, is very interesting, but some items seem to be strange. As anybody who has had any dealing with rock tunnelling knows, the two main items of expenditure are Labour and Explosives. In the Cascade Tunnel article it is only possible on one occasion, *i.e.*, page 637, to calculate the amount of powder used. The figures given for the 8 by 9 drift with a 7½ft. advance, work out at nearly 10 lb. of dynamite per cubic yard. Some time ago a pamphlet on the same tunnel was circulated, and in it the figure came to 12 lb. per cubic yard. These amounts are excessive. The rock must have been burnt out and not forced out.

I am just now supervising a drift in hard granite. We use over 100 drills for a 2 m. round of twenty-six holes. The powder consumption comes to 4 lb. per cubic yard. Size of drift, 2 m. by 2·20 m. I have obtained as much as 2·50 m. advance with the same ratio.

Only the reckless use of powder can explain the advance, and speaks for the high price the contractor has obtained for his work.

The placing of concrete by pneumatic pressure is unfortunately little used here in Europe. I have employed it on the 3½-mile Summit Tunnel in California, and we made a daily advance of 34ft. when placing 2ft. of concrete full lining. Size of tunnel, 22ft. by 25ft.; thickness of lining, 2ft. reinforced.

Another item which would not pass in economical Europe is the concreting in of timber lining.

It would be interesting to know how far the lining in the Cascade Tunnel was affected by explosions after a fifteen to twenty hours' set. On all American tunnels and tunnels in other countries I have worked in, five days were the minimum, and we had to keep at least 500ft. back from the face.

W. J. BRANDS.

Linares (Jaén), Spain, July 8th.

J. E. McCONNELL.

SIR,—I am under the impression that years ago I saw somewhere or other a portrait of J. E. McConnell, the designer in the 'fifties of the L. and N.W.R. "Bloomers," but have so far been unable to track it down. I shall be very grateful to any of your readers who can tell me where a portrait of McConnell is to be found. L. P.

July 17th.

B.E.S.A. SPECIFICATIONS.

ALUMINIUM.

Five new specifications relating to aluminium have recently been issued by the British Engineering Standards Association. Two, numbered 359 and 360, are for 98 per cent. Aluminium Notched Bars and Ingots and Rolling Slabs and Billets, and 99 per cent. Aluminium Notched Bars and Ingots respectively. These deal with the chemical composition of the bars, &c., and the provision of samples for analysis. The other three specifications are for 7 per cent. Copper, 12 per cent. Copper and Zinc-Copper Aluminium Alloy Castings, and are numbered 361, 362, and 363 respectively. The chemical compositions are specified, together with requirements relating to chemical testing, dimensions, margins of manufacture, and freedom from defects. Mechanical tests are laid down and provision is made for the supply of test samples. Copies of these specifications may be obtained, price 2s. 2d. each post free from the Publications Department, British Engineering Standards Association, 28, Victoria-street, London, S.W. 1.

TODD SYSTEM POWDERED FUEL EQUIPMENT ON THE S.S. "WEST ALSEK"

FIG. 1—COAL PULVERISING MILLS

FIG. 2—THE STOKEHOLD SHOWING BURNERS

Pulverised Fuel at Sea—The West Alsek Installation.

SOME months ago the cargo steamer "West Alsek" was set apart by the United States Shipping Board for conversion from hand-firing to pulverised fuel burning on the Todd unit system. The work was carried out at the works of the Todd Shipyards Corporation, following the official tests of the Todd system, which were made jointly with the United States Naval Authorities at the oil fuel testing plant of the League Island Navy Yard, Philadelphia.

The trials of the converted ship were made on June 19th from Hoboken, New Jersey, to Fire Island, and during two runs over a measured mile course and a 12-hour trial, a mean speed of 12·7 knots was attained with the engines running at 80 r.p.m. The trial results were so satisfactory that the Shipping Board immediately took delivery of the steamer and ordered her to proceed to Baltimore for loading. On her run to Baltimore she averaged 11·8 knots with the engines making 75 to 78 r.p.m.

The "West Alsek" was chosen for conversion because she is a typical cargo-carrying steamer. She was built in Seattle in 1918, and is of the two-deck three-island type, with the following dimensions:—Length between perpendiculars, 410ft. 5½in.; breadth moulded, 54ft.; depth moulded, 29ft. 9in. Her deadweight carrying capacity is 8529 tons, and her gross tonnage 5573. She is propelled by a single set of tripe-expansion steam engines of 2750 I.H.P., the steam being supplied from three single-ended Scotch boilers each provided with three furnaces. The designed speed of the ship before her conversion was 9 knots on a daily consumption of 42 tons of coal, but difficulty was met, we learn, in maintaining this speed in Transatlantic service. With the new pulverised fuel equipment not only has the speed of the ship been considerably increased, but it is anticipated that a considerable saving in operating costs will be made.

The coal-crushing and pulverising equipment was specially designed to meet the requirements of the ship. The run of mine coal is fed to a crusher of the high-speed fixed hammer type, which is provided with a hinged bottom in order to facilitate the removal of tramp iron or other solids. Coal may be taken to the crusher, either by gravity from the upper deck or by means of an elevator from the lower cross bunkers. It is crushed to ¼in. size, and it then passes by gravity from the crusher to a screw conveyor running athwartships. The trough of the conveyor is furnished with nine downcomers discharging into hoppers placed immediately above the pulverising mills—as shown on the left of Fig. 1. Each hopper contains about an hour's supply of fuel, and the fuel passes down by gravity through a disc feeder to the individual pulverisers. Arrangements are made to insure that, under sea-going conditions, the some amount of fuel enters each of the nine pulverising mills. When operating under reduced loads, when manœuvring, or when entering port, the supply from one or more of the pulverisers can be cut off as desired.

The arrangement for pulverising shown differs somewhat from that used in the land tests, which were described in an article contributed to the issue of the *Journal* for the American Society of Naval Engineers for May, 1929. In the test plant the pulverisers were motor driven, and were directly attached to the burners. In the actual installation—as will be clearly seen from Fig. 1—the three pulverising units for each boiler are grouped into one unit, which is directly driven by a small Westinghouse steam turbine. The three pulveriser groups are neatly arranged along one side of the stokehold facing the boilers, and are thus handy both for supervision and inspection. Had the original arrangement of an electric motor for each pulveriser and burner been adhered to, it would have been necessary to install special alternating-current generators. To save the initial cost of such new plant, it was decided to use small steam turbines, and to exhaust the steam from them directly to the main and auxiliary condensers. If such an arrangement should be decided upon for a new installation, the heat of the exhaust steam might be effectually employed for raising the temperature of the feed water.

As will be seen from Fig. 2, the pulveriser units, which are of the two-stage centrifugal type, along with an integral fan having a tangential discharge, are connected to the burners by flexible tubing. The burners are fixed to the ordinary Howden furnace fronts, and provision is made for starting up by the filling of a small capacity oil burner as an ignition torch. Should the relative prices of oil fuel and powdered coal make it more economical at some future date to use oil fuel for a part or a whole voyage, the furnace fronts are so designed that oil-fuel burners of large capacity can be readily adapted if they are required. The stream of powdered coal and primary air enters the furnace through an internal diffuser which imparts to it a rotary motion. The rotation of the coal dust particles is further assisted by the secondary air, which enter the furnace through registers provided in the Howden type furnace fronts.

An interesting feature in the design of the boiler uptakes and funnel is the provision of a separate compartment for each of the three boilers right to the base of the funnel and throughout its length. During the official trials coal from the Upper Freeport seam from Preston County, Pennsylvania, with a calorific value of 13,500 B.Th.U's per pound was employed. Its fusing point was 2700 deg. Fah., and the ash content was 12 per cent., with 27 to 28 per cent. of volatiles, 58 to 59 per cent. fixed carbon, and about 2 per cent. of moisture. The system showed great flexibility in control, and the installation may be looked upon as a further forward step in American powdered coal-burning practice for marine service.

Engineers and Hungary.

(From a Special Correspondent.)

I AM afraid that not much of interest to British engineers is to be found in Hungary, that to is say, as regards import of British machinery.

Hungary is a country which has, perhaps with the exception of Austria, suffered more severely from the peace treaties than any other. From a land which covered before the war approximately 126,000 square miles of territory with nearly 21 million inhabitants, it has dwindled to about 35,200 square miles, inhabited by 7½ million people. Gone are all its minerals and the greater part of its forests. It remains an agricultural and pastoral country surrounded by States which have been the gainers by its loss and which it regards with natural antipathy. At present the Hungarian attitude is that of Rachel weeping for her children and who will not be comforted.

The Hungarian Government is fiercely isolationist and has surrounded the country with tariff walls as high, or nearly as high, as any in Europe. The break up of the Austrian Empire has left the legacy of Budapest, a second Paris, cultured, extravagant and too large a burden for an impoverished State to carry.

There is a number of extensive engineering works which formerly ministered to the needs of the entire Austrian Empire, and have now only the reduced requirements of the small pastoral State from which to find employment. As an instance, I may mention the State Railway Locomotive Factory, formerly building locomotives to the number of 300 yearly, and now having to be content with twenty. As a result, these works are frankly endeavouring to find other outlets, in which they are aided by a Government which is prepared to pursue a strongly protectionist policy. The same may be said of the other large factories, which are endeavouring to maintain their existence in the face of difficulties.

Agriculture is now the only hope and the backbone of the country, and should, if properly developed, prove its salvation. The possibilities are great but unfortunately the Government, instead of intensifying production by assisting in the reduction of costs, is maintaining a high level of prices in order directly to benefit the farmers. At the same time it is giving very high protection to other industries, with the result that prices throughout the country are abnormally high and trade is stifled.

So far from Hungary importing machinery, every effort is being made to use her existing resources for export, especially of agricultural machinery and electrical. The manufacture of the former (*i.e.*, agricultural machinery) is largely upon the basis of British practice, and is in virtue of arrangements already existing between British and Hungarian firms. A certain amount of textile machinery has recently been bought from Czechoslovakia, but these purchases were made from stocks which had accumulated and were for disposal at reduced rates.

The balance of trade is adverse, and it is difficult to say whether this is the result of loans which have been raised in foreign countries or whether it is the adverse balance which has necessitated the loans. The latter have been used to develop home industries, but have not succeeded in bringing production costs within competitive limits.

Hungary is, therefore, going through hard times, and one cannot speak encouragingly of the prospects of British engineering trade in general, though the feeling towards this country is one of the best and probably more friendly than to any other.

South African Engineering Notes.

New Type of Tramcar.

A TRAMCAR equipped with a centrally situated embarking or alighting platform, has just been placed in service on the Cape Town tramways. From the platform, admittance is gained to two distinctly separated compartments, one of which will be reserved for non-smokers. The car is of a single-decker type, fitted with two motors. Two additional cars of this type are in course of construction in the company's workshops, and it is expected that one will be completed at the end of June. Both these cars will be placed upon the route from the city up the mountain slope to the residential suburb of Orangezicht. To provide the additional power required for the severe gradient these cars will be fitted with four motors.

New Coalfield in Rhodesia.

A new coalfield has been discovered near the Kafue River, about 190 miles west of Broken Hill in Northern Rhodesia. Information as to the quality of the coal is that it is excellent and the deposit is of great size. If so, it may deprive the Wankie Colliery, near Livingstone, of two of its best customers, the Union Minière Copper Company, in the Belgian Congo, and the Belgian Congo Railways, which at present take nearly half a million tons of coal and coke from the Wankie Colliery, or close to half its output, while the demands from those sources are increasing.

Deepest Mine in the World.

In the Turf shaft of the Village Deep Gold Mine, on the Witwatersrand, in the Transvaal, the shaft sinkers were, in the middle of May, down to a depth of about 7600ft., and it was hoped that by the end of the month they would have reached the total depth called for, namely, 7640ft. The shaft has been sunk 11,000ft. through the rock of the Witwatersrand, though the actual vertical depth is as given above. Even so, it is 2000ft. below the level of the beach at Durban, the Natal port, 500 miles from the Rand.

The shaft sinkers are working in an unvarying temperature of about 80 deg. The heat is one of the greatest difficulties. When the shaft had dropped lower than any other on the Reef, the engineers adopted ice cooling, using 4 tons of ice a day to reduce the temperature of the rock, which is slightly over 95 deg. That, however, did not prove to be a satisfactory method, because of the additional moisture it added to the already nearly saturated air, and it has been abandoned in favour of compressed air, which is carried to the working places in pipes under very high pressure. There it is liberated, and the sudden expansion causes an immediate drop in temperature. The men working in the shaft take 10 minutes to reach their working place. They first drop 4000ft. vertically, and then on a 4000ft. long incline drop another 2000ft. Here they walk along a "cross-over" to the final skip, and are lowered to the bottom of the shaft, 1600ft. below, down a 3000ft. incline.

Electricity for South African Railways.

The new general manager of the South African Railways (Mr. J. R. More) is opposed to any further electrification of the lines, and dealing recently with the suggested electrification of the Durban–Maritzburg section of the Natal main line, he stated that the heavy capital outlay and addition to the working costs which electrification involved, made it impossible to recommend any extension of the electrified system at the present time. The

more expeditious transit of traffic on that section could, in his opinion, be as efficiently and more economically obtained under present conditions, through the medium of steam locomotives of high tractive power, and by doubling the line where necessary. Experience, he said, had shown that only under the most favourable conditions of intensive traffic was there any prospect of meeting the additional cost in interest of the huge capital outlay, and other charges which the adoption of electric traction entailed.

In his evidence before a Select Committee this year Mr. More complained that the charges for current from the Salt River and Colenso Power Stations—the one supplying the Cape Peninsula suburban system and the other the electrified portion of the Natal main line—were too high. The loss on the Cape Peninsula Suburban line was £300,000, as against £100,000 when the line was under steam traction. The railways, he declared, were being strangled in the work of electrification by excessive charges.

Members of the South African Association of Electrical Engineers have already controverted Mr. More's general condemnation of the policy of electrifying railways, and now Dr. H. J. van der Byl, the chairman of the Electricity Supply Commission, has published a defence of the Commission in regard to the allegation of excessive general and administrative charges. Dr. van der Byl states that the Commission now sell 800 million units of electricity per annum, and of that total the railway took 130,000,000 units. Other customers, including seventeen towns, made no complaints. He describes the figures given by Mr. More, in respect of the loss on the Cape Peninsula line, as misleading. When that system was operated under steam, the railways did not, he asserts, charge themselves with the railage on 136,000 tons of coal hauled annually, while the Commission had to pay over £100,000 a year for the service. The line, it should be remembered, was electrified on the understanding that the current would cost 1·25d. a unit, and the railway was actually only being charged 1·20d. In the case of the electricity supplied from the Colenso Station, where Natal coal was obtained cheaply, it was originally estimated that the current would cost 0·5d. per unit, and the price to the railway to-day was 0·448d. It had also to be remembered, Dr. van der Byl urges, that Colenso was over capitalised, and also that the traffic did not come up to expectation. If the electrification of the line were extended to Durban, the cost of current would drop immediately because the two stations, the one at Colenso and the one at Durban, could be linked up, and so the capital expenditure per ton-mile to be hauled would be very much smaller. What was also required was, of course, more traffic to make use of the large surplus of power available. As a matter of fact, owing to road motor transport competition, the quantity of traffic carried had decreased in the case of the Cape Peninsula by 25 per cent.

Durban Dock Facilities.

The Railways and Harbours Department is carrying out an extensive programme of extension and development at the port of Durban, and is considerably adding to the facilities for dealing with cargo. The wharf frontage at the Point is flanked by ten cargo sheds of a capacity of 8,000,000 cubic feet, and fronting the mail boat berth a new fruit pre-cooling store is in course of construction. It is designed to be capable of dealing with any volume of fruit likely to be handled for many years to come, its storage capacity being 2000 tons. The wharf equipment consists of the following cranes: One 50-ton hydraulic stationary; one 10-ton hydraulic travelling; four 10-ton steam travelling; nine 3-ton hydraulic travelling; twenty-six 4-ton electric travelling; eleven 3-ton electric travelling; and one 3½-ton electric mobile. Additionally there are fixed on the wharf twenty-nine electric capstans, used for shunting trucks. Supplementary to the shore cranes is a floating workshop fitted with a 15-ton crane. All the hydraulic cranes mentioned above will gradually be replaced by a similar number driven electrically. Further extension in wharfage is projected at the Cato Creek end in the shape of two new deep-water berths with wharf sheds.

The importance of Durban as compared with the other principal harbours of the country can be gauged by the fact that for the year ended March 31st, 1928, the total quantity of cargo handled, including coal, was 4,995,186 tons, while the total of all other ports was 3,097,206 tons. During the first three months of 1929 the total quantity of cargo handled at Durban was 1,205,528 tons, while the quantity handled by all the other ports was 844,636 tons. Coal exported and bunkered makes up more than half of the cargo dealt with at the port. For last year the quantity of coal shipped and bunkered was 2,705,268 tons. For the year 1928, as a whole, the total tonnage of coal shipped from the Union was 2,737,730 tons, as compared with 2,857,946 tons in 1927, the decrease being due to a smaller demand for coal for export. The quantities shipped through Durban were respectively 2,440,230 tons and 2,518,256 tons, so that practically Durban is the coal port of the Union. These totals do not include coal shipped round to small coast ports of the Union.

The appliances for the shipment of coal are keeping pace with the growth of the export and bunker trade. They are of two types, the first a dumper and bucket plant, and the second a dumper and belt conveyor. In the former, trucks are run by gravitation from the storage lines to an incline which approaches the cradle of the dumper, and are then propelled on to the cradle by means of an electric "pig," and when in position they are lifted and turned bodily over, the coal being dumped into a steel apron, from which it is emptied through chutes into 6-ton buckets on railway trucks. These trucks are then hauled to an adjacent transporter, which lifts the buckets over the ship, when the bottom doors of the bucket open and allow the coal to drop out into the vessel's holds or bunkers. The capacity of this appliance is roughly 400 tons per hour. The second method is similar up to the stage when the coal reaches the chutes, but instead of going into buckets, it is led on to an endless belt running parallel to the wharf, over which the coal is passed until meeting another belt at right angles, by which it is carried and discharged into the ship. The capacity of the belt is 800 tons per hour, so that with both appliances working at full strength, 1200 tons of coal can be handled, which compares very favourably with that of any other port of Durban's relative size and importance.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Declining Activity.

WITH the holding of the midsummer quarterly meeting last week the buying movement of recent weeks spent itself, and the Midland iron market has now settled down to a quiet couple of months. Producers of iron and steel have relatively good order books for the season, and they express no anxiety as to their ability to go steadily on until the autumn demand develops. The position is such, too, that they assert that prices are likely to be maintained at their present level which should assure profitable production. The quarterly meeting did not produce any great bulk of new business, but it was not expected that it would after the substantial purchases and contracts entered into in the weeks immediately preceding it. Consumers of iron and steel have now covered their requirements over the next two months, and only small tonnages to meet extraordinary requirements are likely to form the subject of negotiation during the coming weeks. It was gathered from the reports of manufacturers on 'Change last week that, on the whole, Midland industries are fairly well placed for the time of the year. There are some weak places which it would be good to see strengthened, but the general position gives cause for satisfaction and may be well termed "healthy." During the past week there has been no material change in iron and steel values, the only market alteration being a reduction in the price of galvanised sheets.

Galvanised Sheet Prices.

Galvanised sheet prices have weakened further, some mills now quoting £13 7s. 6d. for twenty-four gauge corrugated sheets. Orders to be put through at this price, however, must be for substantial tonnages. For small business £13 10s. is generally asked. The falling off in export demand and the necessity of filling up rolling programmes is responsible for the giving way of prices. Mill owners' reduction costs have not declined with the fall in sheet values, they are still paying high prices for spelter, consequently they are not anxious to accept business too far forward at the "cut" rates mentioned above. They are hoping for a reinvigoration of consumptive demand in the near future which will enable them to replace sheet values on a more profitable level. The tin-plate business in this district is still in a weak state, and sales are few and of small dimensions. Mills quote 18s., but this price fails to attract buyers.

Pig Iron.

The pig iron situation is unchanged on the week. Producers of Northamptonshire and Derbyshire iron are able to dispose of their production, consequently they see no cause to depart from the recent policy they have adopted of asking premiums over the basis minimum fixed by the Combine. Quite a good call for Midland irons is coming from the North-East, and were there a plentiful supply of coke at the right price additional furnaces would probably be brought into action in this district. About 16s. per ton is now asked for good furnace coke, a price much higher than that which ruled at this time last year, and even at this figure supplies are limited. With nearly thirty additional furnaces put into commission over the country since the year opened, the resources of the coke ovens have been taxed severely, and, as additional ovens have not been commissioned to counterbalance the number of blast-furnaces in action, the high price and scarcity of coke are easily accounted for. Midland smelters report a better call for forge iron. This branch of the industry is probably on a better footing at date than it has been at any time since the post-war boom. The call for foundry grade iron has slackened off, consumers being fully covered over the next three months at least. Smelters are in a better position than is usual at this period of the year, and they express confidence in the outlook. The expansion of consumptive demand will progress, they believe, and the autumn will bring a big accession of new business which they hope to put through at profitable rates. Smelters' order books are well filled and work proceeds regularly at the furnaces.

Steel.

There is no great activity in the finished steel department. Mills turning out sections, joists and plates are moderately well employed, but new business is not being booked as rapidly as is necessary to keep pace with output. Some mills report the receipt of better orders, but that is not generally the case. There has been no interference with controlled prices nor is there, just now, any suggestion of alteration. In the half-products department the foreigner appears to be gradually creeping in again. There is only a limited supply of native bars at £8 7s. 6d., but foreign bars at £7 are plentiful. The increasing price disparity is attracting buyers, and a certain amount of business is going abroad. Continental competition in billets is not so successful, sellers requiring £6 5s. to £6 6s., against the £6 7s. 6d. of Welsh makers, and the £6 10s. to £6 12s. 6d. of local steelmasters. There are, of course, firms which refuse to do business at below £6 15s., but many are prepared to go below that figure if the specification is a favourable one. Imported sheet bars were offered in Birmingham this week at £6 2s. 6d. This is very little below the British price, consequently little business was done. Staffordshire hoops remain firm at £10 per ton.

Finished Iron.

In finished iron as in raw iron quieter market conditions rule; the recent accession of stability is, however, maintained. Consumers have provided for present needs, and are deferring further buying until the necessity arises. Staffordshire ironmasters are satisfied that nothing more than the usual seasonal relapse is entailed, and are of opinion, that with a broadening field of activity, business will recover in the autumn. Meanwhile marked bar mills are likely to be steadily employed, while makers of Crown bars, who have put on some good business of late, are in a moderately strong position. But makers of nut and bolt iron are poorly off, and the probability is that they will remain so unless some unlooked for development in the continental situation should arise. It is impossible for local makers to compete with Belgian sellers of No. 3 iron, and this material now forms the basis of bulk of the nuts and bolts made in this district. The demand for iron strip keeps up, and £11 per ton is readily paid for supplies. The tube trade is busier, and wrought iron tube strip is playing a larger part in the production of tubes than it has done for some years past. Values of marked and Crown bars are unchanged at £12 and £10 respectively.

Steel Scrap.

Scrap is a firm market, heavy steel making £4 per ton delivered South Wales. Large exports have of late been made to the Continent, and this, together with the shortage of basic pig iron, is responsible for the limited supply now available. Birmingham merchants dispose of all the material they can secure and are not inclined to entertain offers.

Decrease in Exports.

Midland manufacturers regret to learn of the substantial decreases, when compared with the corresponding period last year in exports during June. They note that although a large share of the total decline in manufactured goods is debited to the textile trades, exports of machinery fell from £5,052,708 to £3,794,206, while exports of iron and steel fell from £5,645,013 to £4,784,542. The decrease of £818,000 in the vehicles group came mainly under the heads of ships and railway material; exports of motor cars and parts were higher in value than last year. It is commented upon that imports of iron and steel during the month—234,208 tons—were higher than those of June last year—210,405 tons. The total imports of iron and steel for the year to date, however, still compare very favourably with those of last year, being 1,339,805 tons, compared with 1,542,299 tons.

Electricity Progress in the Midlands.

The annual report of the South-West Midlands Advisory Joint Committee to the Electricity Commissioners indicates considerable activity during the year, particularly in the Worcestershire and Warwickshire areas. The report shows the generating plant capacity to be 256,500 kW. The units sold show an increase of 12¼ per cent. at 422,500,000 units. Units per head of population sold increased from 228 in 1927–8 to 255 in 1928–9. The number of consumers increased during the year by 20 per cent.

Railway Orders.

Midland rolling stock firms have secured more orders for railway equipment for overseas. The latest to come to hand include that for four all-steel 40-ton bogie hopper wagons, for the Federated Malay States Railways to the Birmingham Railway Carriage and Wagon Company, Ltd.; 98 bogie trucks for the Indian State Railways to the Metropolitan-Cammell Carriage Wagon and Finance Company, Saltley; four express locomotives to Robert Stephenson and Co., Ltd., Darlington; 1440 steel axle boxes to the Patent Axle-box and Foundry Company, Limited, of Wolverhampton.

Unemployment.

Unemployment in the Midland area unfortunately shows no sign of improvement, the figures steadily declining week by week. The latest statistics show an increase on the week of only 336, but nevertheless it is a retrograde step. The total for the area now stands at 163,100, to which Birmingham contributes 23,225, or roughly 470 more than a week ago.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Manchester-Altrincham Electrification Progress.

THE placing of orders for plant and equipment during the past week in connection with the electrification of the old Manchester South Junction and Altrincham line between London-road Station, Manchester, and Altrincham, a distance of something over 8 miles, marks a definite stage in the progress of the scheme. As distinct from the third-rail system of electrification which the London, Midland and Scottish Company has adopted in Lancashire in the case of the Manchester–Bury and Liverpool–Southport lines, overhead equipment is to be used on the Manchester–Altrincham route, and it has necessitated a good deal of alteration of the level of the track under the existing bridges in order to provide room for the equipment. This work has been in progress since early in the year and about half has now been completed, so that an early start is expected to be made with the erection of the overhead equipment. The orders already placed with the British Thomson-Houston Company (rotary converters and sub-station equipment), Callender's Cable and Construction Company (overhead equipment), and the General Electric Company (rolling stock electrical equipment), account for a total expenditure of about £200,000, and important contracts have still to be placed for rolling stock, high-tension wiring, and the erection of sub-stations at Cornbrook and Timperley, and new traffic stations at Navigation Crossing and Dane-road, Sale. Current will be supplied by the sub-stations by the Stretford Electricity Board, at a pressure of 11,000 volts. The work of electrification is expected to be completed and the line open for traffic under the new conditions in about eighteen months.

Planning New Roads.

Manchester has lost little time in considering the problem of road construction in the light of the Govern-

ment's announced scheme of public expenditure for this purpose as a partial solution of the problem of unemployment. A number of road schemes which it is proposed to submit to the Ministry of Transport with the object of securing grants-in-aid have been considered by the Town Planning Committee, and at its last meeting instructions were given for the preparation of detailed plans and estimates.

Industrial Conditions.

The situation in the Lancashire engineering and allied trades is discussed by the Manchester Chamber of Commerce in the course of its monthly review of general industrial conditions. The recovery of the machine tool trade, it is pointed out, continues, and as the demand comes from most of the engineering sections, it is regarded as a proof that the industry as a whole is doing better. There are exceptions, but constructional engineers, the heavy electrical firms, and cable makers, among other branches, are well engaged, and boilermakers have had rather more work. Textile machinists, for the most part, are unable to keep their works fully employed, although Japan, India, and parts of the Continent have placed a fair number of orders. The progress of the reorganisation movements in the home cotton trade is being watched with interest, as they appear likely to lead up to orders for new machinery.

Non-ferrous Metals.

Price movements, in one direction or the other, have been more markedly in evidence this week in connection with the non-ferrous metals than for some time, and interest in the market has been stimulated accordingly. In the tin section, more particularly, there has been renewed "bullish" sentiment. This has resulted in a rise on balance for the week of nearly £10 a ton, prices at the moment of writing being higher than at any time during the past four months. Speculators have been rather less prominent of late, but the improvement in the statistical position, as reflected in smaller domestic stocks of the metal, to say nothing of hopes from a stabilisation of the producing industry, has aroused increased interest. It is probably the fact that the "bulls" are for the time being in the ascendancy that is largely responsible for the advance. Whether they will be able to maintain the position is another matter. Profiting by past experience of the metal, consumers are not inclined to act with anything but extreme circumspection. Conditions in respect of copper are the reverse of those which now obtain in the tin market, and prices of standard metal continue to sag, the value of cash metal at the time of writing being only fractionally above £70 a ton, which is the lowest point touched this year. It is interesting to reflect that, as recently as the end of March last, quotations were only a pound or two below £100 a ton. Naturally, this weakness inspires caution among trade buyers, for it is well known that the supply position now is much less stringent than it was made out to be a month or two ago. Freer offerings of both lead and spelter have served to reduce prices substantially, current values in each case being appreciably lower than they were a week ago, thus continuing the weak tendency that has lately been in evidence.

Iron and Steel.

There is still a remarkably strong tone in the Lancashire pig iron market, and the call for deliveries of the metal against contracts, notwithstanding the fact that industrial operations are being influenced to some extent by annual holidays, is maintained at a satisfactory level in the aggregate. The result is, more especially as producers are exceptionally well sold forward, that prices are very firm all round, with Midland varieties—Derbyshire and Staffordshire—at 72s. and 73s. per ton, Middlesbrough at about 86s., Scottish at from 91s. to 92s., and hematite at 87s. 6d., all delivered equal to Manchester. Bar iron makers locally report only a moderate inquiry, with Lancashire Crown quality material quoted at £10 15s. per ton and seconds at £9 15s. Constructional engineers are specifying for somewhat better quantities of steel, and general engineers, locomotive builders, electrical engineers, and bright drawers are all taking reasonably satisfactory supplies. Sections and joists are quoted at £8 2s. 6d. per ton, tank plates at £8 17s. 6d., boiler plates at £9 17s. 6d., large bars at £9 2s. 6d., and small re-rolled bars at about £8 5s. Continental finished steel keeps steady on the whole, but there has been some weakness in the semi-finished department, and prices are being shaded to the extent of a shilling or two. The demand, however, from users in this part of the country is on a comparatively quiet scale.

BARROW-IN-FURNESS.

Hematites.

Conditions in the hematite pig iron trade of this district remain satisfactory. There is a steady volume of trade, smelters hold good orders, covering some three months ahead, and there is every prospect of a good run of business for some time to come. There are now only twelve furnaces in operation, which number is not up to normal. The Carnforth and also the Askam ironworks have been idle for a long time, and there is no immediate chance of restarting. Local requirements are maintained, and business is being done in special iron for overseas.

Iron Ore.

There is a steady call for hematite iron ore for local account, and for best qualities there is also a demand on the part of Scottish and also East Coast smelters. Importations of foreign ores are quiet.

Steel.

In the steel trade there are no new features of note. The demand for rails is easy, both on home and overseas account, and only small orders are being offered. For hoops there is a good demand, largely on overseas account, while bars and small stuff are in fair call. There is a limited trade in billets, but a fair demand for castings. At the works there is activity in most of the departments, rails forming the chief output.

Fuel.

Steam coal is in steady demand, and coke from the East Coast ovens is largely used, as also are Cumberland sorts.

SHEFFIELD.

(From our own Correspondent.)

The Steel Trade Position.

THE situation of the steel industries of Sheffield and district has undergone very little change for some months. In broad general terms, the description given several times recently will still apply, namely, that the basic steel section is busy, while special departments are also well employed, but that acid steel is very quiet. Even in those branches of commercial steel which are active, prices are severely cut, and little profitis to be obtained from much of the business on hand. The returns of iron and steel exports for June show a falling off—a great contrast to the expansion which had been in operation for several months previously—but the loss may be more apparent than real, as the reports from firms are not always up to date. The automobile and other newer industries in the country are still taking large quantities of Sheffield special steel. The weakness of the railway steel department continues without relief, and there is little demand for wagons for private owners. Confidence in an early recovery of the steel trade is still entertained. Sir William Ellis' recent speech indicated that steel firms are willing to spend money on reconstruction of plant, and the working of the de-rating legislation will bring about considerable relief. A department of local trade which has recently shown improvement is that which produces the better classes of wire. The output from this industry is now on a larger scale than at the beginning of the year. The large continuous wire rod rolling mill at Templeborough has been well employed for several months, turning out a huge quantity of material for which there is a ready sale.

Cutlery and Plate.

The condition of the cutlery and plate industries also shows little change. Only a minority of firms is able to report satisfactory order books, and the total production is much below the level of this time last year. While stainless steel table cutlery is still produced in large quantities, the branch is not enjoying the same amount of prosperity that it did a few years ago. The general trade done at home, through shopkeeping channels, is very quiet, and the latest returns show that there has also been a falling off in the export department. There had been a continuous growth in the overseas trade since the beginning of the year, but the June total of exports, at £71,443, was £30,000 less than in May, and £22,000 less than in June of last year. All kinds of cutlery, including safety razor blades, were affected by the decline, and the only overseas markets which did not show a falling off were Norway and Chile. The figures for the first six months of this year are, however, equal to those of the corresponding period of 1928. The returns reveal a striking increase in the imports of cutlery, the figure of which, for June, was nearly double that for May, and more than double that for June last year. The six months' total is one of the highest ever recorded, being £411,018, as compared with £263,000 in 1928 and £220,000 in 1927. There has been a revival of the controversy regarding the regulation of shops in which grinding is done. The regulations have been in force more than half a year, and are being complied with in all but a comparatively small number of cases, but the grinders who are opposed to artificial wheels are apparently still hoping for some modification of the new rules. The great majority of makers of tools and cutlery have avoided the expense of alterations to their plants by installing artificial stones, large numbers of which are now being used in the city. There are two makers of these stones in Sheffield, and seven or eight more in other parts of the country.

Tool Exports Down.

The export of tools during June, like that of cutlery, showed a serious decline, the figure being nearly £100,000 less than that for May, and £50,000 down on June of last year. The month's total was the lowest of the year, and the decline was shared by all sections of the trade. The drop on the six months, however, is only £50,000 as compared with 1928. The import of tools and implements remained at a high level, and foreign tools show an increase in the first half of this year of £57,000. The exports, however, are considerably larger than the imports.

Railway and Other Orders.

Several orders of interest, given to Sheffield and district firms, have been announced during the past week. The Metropolitan-Cammell Carriage, Wagon and Finance Company is to supply eighty-seven bogie trucks to the Indian State Railways; and Charles Roberts and Co., of Horbury Junction, near Wakefield, twenty-eight oil tank wagons for the Kenya and Uganda Railways. Ambrose, Shardlow and Co., engineers, Ealing Works, Sheffield, have secured in open competition an important order for micrometers from H.M. Office of Works. A brick kiln of exceptional size is being made by General Refractories, Ltd., of Sheffield and Worksop, for Yorkshire Amalgamated Products, Ltd., of Doncaster. The kiln is for the Bawtry Silica Brickworks, and will be the largest so far built there, its holding capacity being approximately 30,000 silica bricks. It will be of the same type as the four recently erected by General Refractories at the Worksop Brickworks.

Developments at Staveley.

Extensions of the soda and chlorine plants at the Devonshire Works of the Staveley Coal and Iron Company, which were started up last week, will result in increased sales of the company's numerous by-products by the manufacture of pure hydrochloric acid and liquid chlorine, and the existing output of bleaching powder and caustic soda will be considerably enlarged. The plant is being put on full load at once, and will find work for some fifty additional men. It occupies a ground space of about 9000 square yards, and has been in course of erection for some months. It will utilise current generated from the giant gas engines, installed some fourteen months ago, which will now be given a more uniform load curve, as a proportion of gas which is at present blowing into the atmosphere will be used to produce the power necessary for the new installation. The plant will take a continuous load of 2000 to 2500 kW of electrical energy transmitted at 6600 volts. The electrolytic cells and general lay-out have been designed and erected by the company's own engineers.

Water Matters.

Sheffield is very fortunately situated for water in this time of drought. While several large towns in the West Riding have found it necessary to restrict supplies Sheffield is able to sell 1,000,000 gallons per day, as a temporary measure of relief, to its less fortunate neighbour, Barnsley. The mains of the two undertakings have been connected at Uskers, about a mile and a half from the Langsett Reservoirs of the Sheffield Corporation. Bakewell Rural District Council has decided to apply to the Ministry of Health for sanction to a loan of £14,000 for the purpose of a water supply to the parishes of Hathersage and Outseats.

A Large Purchase.

In a previous reference to the negotiations being carried on by the Frodingham Iron and Steel Company for the purchase of the assets of the Yorkshire Iron and Steel Company, Leeds, it was pointed out that the object of the Frodingham Company was to acquire the ironstone mines of the Leeds undertaking, at Scunthorpe, and that the other properties would probably be re-sold. It is now ascertained that the major portion of the properties has been sold by the Frodingham Company to Thos. W. Ward, Ltd., of Sheffield, whose purchase includes the blast-furnaces and works near Ardsley, the collieries near Morley, and a large acreage of land used for industrial and agricultural purposes. It is thought that arrangements will be made to reconstruct those sections of the plant which are likely to become successful industrial propositions, while the obsolete portions will probably be dismantled.

Personal.

Sir Robert Hadfield, Bart., chairman of Hadfields, Ltd., Sheffield, recently completed his seventieth year, and the event has been celebrated by two presentations. Sir Robert's fellow-directors have given him a bronze bust of himself by Mr. J. F. Halnon, which they have had erected in the board room at the firm's East Hecla Works; and the managers and foremen of the works have given him an illuminated address. The death occurred last week-end of Mr. T. V. Miles, managing director of the Thorncliffe Ironworks of Newton, Chambers and Co., Ltd. He had been at Thorncliffe since 1908, and was previously at Tredegar, Glasgow, Staveley, and Holwell, in addition to which he carried out an investigation, on behalf of several important firms, into iron and steel foundry methods in the United States and on the Continent of Europe. He was Vice-president of the British Cast Iron Research Association, and for some time served on the Committee of the British Engineering Standards Association.

NORTH OF ENGLAND.

(From our own Correspondent.)

Ironworks to Restart.

THE industrial situation in the North of England continues to improve, and there is a substantial increase in the volume of general trade. The iron and steel works are fully employed, and in order to meet the increased demand for pig iron more producing plant is being put into operation. The Linthorpe–Dinsdale Smelting Company, of Middlesbrough, has decided to restart its Linthorpe Ironworks next week, when two blast-furnaces will be rekindled for the production of hematite. The works were closed down during the General Strike in 1926, and have remained idle ever since. With these two furnaces, the number in blast on the North-East Coast will be increased to forty-six, as compared with thirty-one in operation at the beginning of the year. The South Durham Steel and Iron Company is also restarting a plate mill at its Malleable Works, Stockton, which has been idle for two years. The wave of prosperity on Tees-side has found the engineering trade short of labour, and to cope with work in hand, about 300 men have been transferred from the Tyne and Wear districts. This shortage of mechanics is accounted for by the fact that the period of depression has been so long that apprentices have not been in training, and a good many of the experienced journeymen have either drifted into other trades or left the district.

Cleveland Iron Trade.

The position in the Cleveland pig iron trade does not show much change on the week. If anything, business is a little quieter, but this is due to the advent of the holiday season. A disquieting feature is the continued rise in the cost of raw materials. Coke supplies are scarcely adequate for present needs, and foreign ore values are still advancing. Only as a preferential rate can blast-furnace coke be obtained at 21s. 6d. per ton for delivery at the works; very much higher rates are being quoted and paid for export, and, of course, this increased cost is likely to be passed on ultimately to the consumers. Meanwhile, however, Cleveland prices are unchanged. Merchants can only supply very small spot lots, and a considerable quantity of iron is being brought into the district from other

areas to make up the deficiency. Ironmasters are now in a position to accept orders for the last quarter of the year, but there is no rush of business. However, producers can well afford to wait, as they have healthy order books. No. 1 Cleveland foundry iron is 75s.; No. 3 G.M.B., 72s. 6d.; No. 4 foundry, 71s. 6d.; and No. 4 forge, 71s.

Hematite Pig Iron.

In the East Coast hematite pig iron trade prices are irregular, with the tendency upwards. Producers are well placed as regards orders, and are not keen to sell on terms obtainable, which they declare are unremunerative, but second-hands have considerable marketable holdings, and are still accepting round about 74s. 6d. for ordinary qualities. Makers, however, ask 75s. to 75s. 6d.

Ironmaking Materials.

Scarcity of tonnage is delaying deliveries of foreign ore, due against running contracts, and freights are on a high level. Some consumers are much in need of supplies. New business of moment is unheard of. Nominally, market rates are at the equivalent of best Rubio at 24s. c.i.f. Tees. The freight Bilbao–Middlesbrough is 8s. Fear is expressed that the additional make of coke will be inadequate to meet increasing needs, and, in view of greater scarcity, values are very stiff. Durham medium blast-furnace qualities are put at 21s. 6d. delivered to works on the North-East Coast.

Manufactured Iron and Steel.

Tonnage output in the manufactured iron and steel trade is heavy, and work in hand ensures active operations at the works for some time to come. In the semi-finished iron and steel departments, business continues on quite a good scale, although in one or two of the consuming branches quantities required are not so large as of late. Finished steel producers have little cause for complaint so far as the order books are concerned, but improvement in sales and in prices would be welcome. Quotations, all round, are steadily firm.

The Coal Trade.

The collieries in the North of England have no cause to complain about the present condition of the coal market. Orders are as plentiful as could be desired, prices are very good, and given an uninterrupted supply of tonnage heavy shipments should continue over the next few weeks. The only adverse feature in the situation at the moment is the uncertainty of obtaining fresh boats to maintain shipments at the present rate. Some uneasiness is caused by the fact that during the past few days, the supply of new boats has been smaller, and freights have risen a few pence. One of the effects of the tonnage shortage is that, where shippers have to take out coal from the collieries and cannot secure tonnage, supplies are thrown on the open market; but so good is the general demand that odd lots are snapped up at current prices by merchants who may be fortunate enough to have boats. Firm prices are being maintained for all classes of coal, and despite the fact that they are higher than they have been during the past month, business is being secured against foreign competition. In the Northumberland section there is a steady trend, best steams remaining at 15s., Tyne primes 14s. 6d., and seconds 14s. These large screened coals are in steady output again. The collieries seem to be clearing small steam fuel, and prices of these are held at 8s. 6d. for seconds, 9s. to 9s. 6d. for bests, and 10s. for specials. There is an active Durham market, especially for favoured makes. Big business has been placed with some of the collieries, and, judging from inquiries, a good deal more is about to be transacted. The most sellers are prepared to concede on current rates to the end of the year is about 6d. Plenty of business offers over next year for gas and coking coal at about 1s. less than the prompt figures. Coking coal has been made an outstanding trade in view of the rising flow of business lately, and quotations, although not actually altered, are tending upwards. Unscreened coking is 16s. 9d. to 17s., and smalls anything from 16s. to 16s. 6d. Good gas coal is in keen demand, and bests are strong at 16s. 9d., with specials at 17s. 6d. Bunker coals show a quietly steady position, with bests and superiors unchanged at 17s. to 17s. 6d., and ordinary grades at 16s. to 16s. 3d. Well-booked positions and a steady inquiry characterises most branches of the coke market. There is a rather wide margin of price for ordinary patent foundry coke at 21s. to 23s., which suggests a variable situation, but the main trend is to firmness. Gas coke is generally steady at 21s. 6d. to 22s.; special foundry coke is 24s. to 26s.; and beehive coke, 26s. 6d. to 30s.

SCOTLAND.

(From our own Correspondent.)

Holiday Markets.

WITH the majority of the steel works, ironworks, and collieries on holiday, business is practically at a standstill, and will probably remain so until the middle of next week. In some cases a restart will be made next Monday, but in others the vacation may be extended for some days longer. The outlook at the shipyards is still uncertain, and the same may be said of the iron and coal trades. Some recent improvement is noted in the steel trade in certain districts, but, on the whole, the position is not too satisfactory.

Steel.

Makers of heavy steel had a comparatively good output just prior to the holidays, and some will be in a fairly good position when the works restart. Steel sheets have been irregular, the light varieties being in better demand than the heavy descriptions. The demand for galvanised sheets has improved, but business is still affected by the heavy stocks still held abroad. Tube works are as yet well placed, despite a slight falling off in demand.

Iron.

Bar iron makers have had a very lean time for some months past, and present indications hold out little hope of an early improvement. In the re-rolled steel department, too, there is less activity, the position being largely affected by the renewal of keen continental competition. Prices of bar iron are unchanged, and re-rolled steel is still quoted £8 per ton home and £7 15s. per ton export.

Pig Iron.

Business in pig iron has not expanded as was expected, but owing to production cost minimum prices have been raised by 2s. per ton for hematite and 1s. 6d. per ton for foundry qualities.

Scrap.

Scrap materials have been in somewhat better supply of late, and prices have weakened a shade to 76s. 3d. for heavy steel and 60s. per ton for cast iron machinery scrap.

Coal.

With the collieries in the West of Scotland and Fifeshire on holiday, the market is more or less inactive. In the Lothians best steams are comparatively well booked at recent prices, and washed materials are scarce and firm. Aggregate shipments amounted to 294,884 tons, against 306,945 tons in the preceding week and 226,876 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Conditions.

THESE are rather dull days in the steam coal trade, but in the anthracite section the conditions are very steady and would in fact be better if only tonnage was more freely obtainable for the shipment of coals to Canada. Homeward rates of freight are, however, so unsatisfactory that it is difficult to get owners to send their steamers out except at a rate of freight which can only be described as exorbitant. The tonnage question is also a very important one so far as the steam coal section is concerned. There has been a shortage of supplies for weeks past, and it can scarcely be said that the position displays any improvement. At the end of last week there were as many as thirty-six idle tipping appliances at the various docks in this district and only four steamers waiting. Week-end arrivals improved the situation temporarily, inasmuch as on Monday the number of tipping appliances which were not working was reduced to twenty, and one steamer was waiting for a berth. The surprise is that shipments keep up so well considering the general state of the docks. Unfortunately, there is no material expansion in chartering operations, so that it does not look as if any real pressure in loading will be seen this side of the August holidays. It is more likely that the demand for prompt steamers will continue for the next few months, as the shortage of tonnage generally will be accentuated by the delays which steamers are meeting with at South American ports. The inquiry for steam coals shows no new feature, and is comparatively quiet, while so far as contract operations are concerned, there is no new development, though it is understood that the Portuguese State Railways are coming in the market for about 30,000 tons of steam smalls for delivery over the next few months at Lisbon and Oporto.

Tin-plate Trade Wages, &c.

The annual meeting of the South Wales Tinplate Trade Joint Industrial Council on Friday last approved the new sliding scale agreement for the regulation of wages which had been agreed upon the previous day by a joint committee. Under this scheme the selling price of tin-plates at twelve representative works is to be ascertained, and the wages basis will be fixed on it, subject to the costs of manufacture based upon the purchasing price of block tin and tin-plate bars over a period of three months being eliminated. This will govern each succeeding three months. The Industrial Council also considered other matters which were brought forward by the men's representatives, and among them was a complaint that new works and mills were being erected, notwithstanding the fact that the industry is only able to operate up to 75 per cent. of its present capacity. The employers frankly admitted that they were helpless in this matter, as they had no control over those manufacturers who were desirous of extending or improving their plant. The employers also declined to agree to the request of the men to pay full wages during the annual holiday week, their reason being that the cost was too heavy.

Suggested Dock Improvement.

The secretary of the Swansea Chamber of Commerce has recently addressed a letter to the two representatives of Swansea in Parliament with reference to the necessity for the improvement of the dock and railway facilities of that port, the idea being that they should submit the matter to Mr. J. H. Thomas with a view of his approaching the Great Western Railway Company. The letter points out that the trade of the port now exceeds seven million tons, of which probably 95 per cent. passes through the King's, Queen's and Prince of Wales Docks. These three docks are all served by one lock, which occasionally is severely taxed, and occasions have arisen in the past when the whole of the traffic of steamers coming in and going out could not be coped with on the tide. If Swansea's trade increases, and there is no doubt that it will, this one entrance will be totally inadequate to serve the needs of the port. But, in addition to this question of capacity, there is the much more serious one of accident happening to any vessel in this one entrance causing a stoppage of practically the whole trade of the port. It may be improbable, but such an occurrence is not impossible, and the consequences are too serious to contemplate. All dock labour would cease. Coal shipments would stop, which would be reflected upon collieries serving the port, vessels intended for Swansea would be diverted to other ports, and directly or indirectly all members of the community would be affected. The Chamber of Commerce considers that the question could usefully be submitted to Mr. J. H. Thomas with the idea of his approaching the Great Western Railway Company as to the provision of an alternative entrance.

Current Business.

The tone of the steam coal market continues to be quiet, and the trouble of many collieries is to get prompt orders for large coals. The lack of a ready outlet for these coals is that many pits have had to temporarily suspend working, and this is an expensive matter for them. Those producing the best quality of Admiralty large have been more fortunate, as they are well stemmed, and are very fully booked up for the whole of this month; it is the inferior grades which have suffered most. The irregular working of pits has of course had the effect of limiting the output of smalls, and these and sized coals continue to be firm spots in the market. There is no change in patent fuel, and coke and pitwood keeps about steady.

CONTRACTS.

BIRMINGHAM ELECTRIC FURNACES, Ltd., has received an order from David Brown and Sons (Huddersfield), Ltd., of Huddersfield, for a furnace having a usable hearth 14ft. long by 3ft. 3in. wide, with a maximum rating of approximately 200 kW. This furnace, which is to be double-ended and will be used for re-heating and carburising, will, it is believed, be the largest electric furnace for this purpose in the country.

THE WESTINGHOUSE BRAKE AND SAXBY SIGNAL COMPANY, Ltd., has received an order to supply the electro-pneumatic signalling equipment on the new section of subway line from Federico Lacroze to Callao on the F.C.C. de Buenos Aires. This section comprises the terminal station at Federico Lacroze and 6 kiloms. of double track, constructed partly through tube and partly through "cut and cover," and the order covers the complete apparatus for the work, including three power frames of twenty-three, fifteen, and eleven levers each, two-aspect colour light signals, electro-pneumatic train stops, and point lay-outs, impedance bonds, track circuits, &c.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

R. H. NEAL AND CO., Ltd., of Ealing, London, W. 5, ask us to announce that they have been appointed sole representatives for London and the South-Eastern Counties for the British Flottmann Drill Company, Ltd., of Allensbank Works, Cardiff.

THE PLENTY-STILL OIL ENGINES, Ltd., of Newbury, asks us to announce that it has been appointed the sole selling agent for the United Kingdom for the mechanical lubricators made by Alex. Friedmann under the heading of "Friedmann Mechanical Lubricators."

MR. ALAN D. MACLEAN, B.Sc., A.M.I. Mech. E., A.M.I.E.E., has resigned his position as chief assistant engineer of the Yorkshire Electric Power Company in order to take up the post of general sales manager to International Combustion, Ltd., Africa House, Kingsway, London, W.C.

THE SOCIETE DES CHANTIERS ET ATELIERS AUGUSTIN NORMAND, of Havre, informs us that it has been called in by the Rotterdamsche Droogdok Maatschappij to assist it in the construction of three submarines for which it has received orders from the Dutch Naval Authorities.

THE KEIGHLEY GEAR CUTTING COMPANY, of Aireworth Works, Keighley, asks us to announce that it has purchased the entire plant, goodwill, stock and records of Messrs. E. Arnold Pochin and Bro., gear specialists, of Trafford Park, Manchester, and has retained the services of Mr. Arnold Pochin. It will continue the manufacture of gears previously made by Messrs. Pochin and will be prepared to undertake replacement orders.

CATALOGUES.

J. AND E. HALL, Ltd., Dartford, Kent.—Brochure concerning refrigerating and ice-making machinery.

G. DIKKERS AND CO., Hengelo, Holland.—Bulletin No. 1, "A short description of 'Dikkers' works."

B.S.A. TOOLS, Ltd., Sparkbrook, Birmingham.—Leaflet dealing with B.S.A. screwing sets. Mark IV.

JAMES KEITH AND BLACKMAN COMPANY, Ltd., 27, Farringdon-avenue, E.C. 4. Pamphlet K.189 on "Dust Removal."

J. DAVIS AND SON (Derby), Ltd., Derby.—Illustrated catalogue of "Davis-Derby" miners' safety lamps of all types.

POWER GAS CORPORATION Ltd., Stockton-on-Tees.—Booklet C.F. 1, giving particulars of the "Clinkerfree" gas producer.

SIEMENS BROTHERS AND CO., Ltd., Woolwich, S.E. 18.—Pamphlet 500 A, "Siemen's Automatic Telephone Exchanges."

O. N. BECK, 11, Queen Victoria-street, E.C. 4.—Leaflet:—"Shift your belt in two seconds with the 'Record' belt shifter."

FERRANTI, Ltd., Hollinwood, Lancs.—Details of the "Ferranti" multi-range D.C. test set and the "Ferranti" valve tester.

WORTHINGTON-SIMPSON, Ltd., Queen's House, Kingsway, W.C. 2.—Bulletin WS, 1113-A, describing Worthington feed-water heaters.

BUTLER MACHINE TOOL COMPANY, Ltd., Victoria Ironworks, Halifax.—Two sectional catalogues of crank shapers and general purpose lathes.

TAP FOR OIL DRUMS.—A simple and ingenious tap for oil drums has been sent to us for inspection by Philips Telescopic Taps, Ltd., of 62, Pall Mall, S.W. 1. It consists of a short length of solid drawn steel tubing provided at one end with a flange for attachment to a container. Within this tube slides telescopically another tube closed at both ends, but provided with a large circular opening near the outward end. By pulling the inner tube outwards and rotating it an appropriate opening in it coincides with a similar opening in the outer tube and allows the oil to flow out through the large circular opening first mentioned. The tap is closed by the reverse action, a simple spiral cam on the inner end of the outer tube causing a rubber washer to effect perfect sealing. In the closed position there is practically no projection, so that the transport or storage of containers is facilitated.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
(1) Native	19/6 to 22/-
(1) Spanish	24/-
(1) N. African	24/-
N.E. COAST—	
Native	18/- to 21/-
Foreign (c.i.f.)	24/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	4 0 0	—
No. 1 Foundry	3 18 6	—
No. 3 Foundry	3 16 0	—
N.E. COAST—		
Hematite Mixed Nos.	3 15 0	3 15 0
No. 1	3 15 6	3 15 6
Cleveland—		
No. 1	3 15 0	3 15 0
Silicious Iron	3 15 0	3 15 0
No. 3 G.M.B.	3 12 6	3 12 6
No. 4 Foundry	3 11 6	3 11 6
No. 4 Forge	3 11 0	3 11 0
Mottled	3 10 6	3 10 6
White	3 10 6	3 10 6
MIDLANDS—		
(3) Staffs.—	(*Delivered to Station*)	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 11 0	—
,, ,, Foundry	3 13 6	—
(3) Northampton—		
Foundry No. 3	3 10 0 to 3 12 6	—
Forge	3 6 0 to 3 8 6	—
(1) Derbyshire—		
No. 3 Foundry	3 8 6 to 4 1 0	—
Forge	3 4 6 to 3 17 0	—
(3) Lincolnshire—		
No. 3 Foundry	3 12 6	—
No. 4 Forge	—	—
Basic	—	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 5 6 (a) / 4 7 6 (b) / 4 11 0 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	10 5 0	9 15 0
Best	—	—
N.E. COAST—		
Iron Rivets	11 10 0	—
Common Bars	10 15 0	—
Best Bars	11 5 0	—
Double Best Bars	11 15 0	—
Treble Best Bars	12 5 0	—
LANCS.—		
Crown Bars	10 15 0	—
Second Quality Bars	9 15 0	—
Hoops	13 0 0	—
S. YORKS.—		
Crown Bars	11 0 0	—
Best Bars	11 10 0	—
Hoops	12 0 0	—
MIDLANDS—		
Crown Bars	10 0 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	9 0 0 to 9 5 0	—
Gas Tube Strip	11 0 0	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates (Marine)	10 10 0	10 0 0
,, ,, (Land)	10 0 0	10 0 0
Ship Plates, ½in. and up	8 12 6	7 12 6
Sections	8 2 6	7 2 6
Steel Sheets, ¼in.	9 0 0	8 7 6
Sheets (Gal. Cor. 24 B.G.)	13 17 6	13 12 6 to 13 15 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 12 6	—
Angles	8 2 6	—
Boiler Plates (Marine)	10 10 0	—
,, ,, (Land)	10 0 0	—
Joists	8 2 6	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	8 2 6	—
Soft Billets	6 17 6	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 10 0	—
Light Rails	8 15 0 to 9 0 0	—
Billets	6 15 0 to 9 10 0	—
MANCHESTER—		
Bars (Round)	9 2 6	—
,, (Small Round)	8 5 0	—
Hoops (Baling)	10 0 0	9 15 0
,, (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
,, (Lancs. Boiler)	9 17 6	—
SHEFFIELD—		
Siemens Acid Billets	9 10 0	—
Hard Basic	9 2 6 and 9 12 6	—
Intermediate Basic	7 12 6 and 8 2 6	—
Soft Basic	7 0 0	—
Hoops	9 10 0 to 9 15 0	—
Soft Wire Rods	8 10 0	—
MIDLANDS—		
Small Rolled Bars	8 5 0 to 8 15 0	—
Billets and Sheet Bars	6 12 6 to 6 15 0	—
Sheets (20 W.G.)	11 10 0 to 12 0 0	—
Galv. Sheets, f.o.b. L'pool	13 7 6 to 13 12 6	—
Angles	8 2 6	—
Joists	8 2 6	—
Tees	9 2 6	—
Bridge and Tank Plates	8 17 6	—
Boiler Plates	9 17 6	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	18/1½ to 18/6
Block Tin (cash)	213 15 0
,, ,, (three months)	217 7 6
Copper (cash)	70 1 3
,, (three months)	70 17 6
Spanish Lead (cash)	22 13 6
,, ,, (three months)	22 15 0
Spelter (cash)	25 0 0
,, (three months)	25 3 9
MANCHESTER—	
Copper, Best Selected Ingots	75 5 0
,, Electrolytic	84 15 0
,, Strong Sheets	110 0 0
,, Tubes (Basis Price), lb.	0 1 3½
Brass Tubes (Basis Price), lb.	0 1 1½
,, Condenser, lb.	0 1 3½
Lead, English	24 5 0
,, Foreign	22 15 0
Spelter	25 7 6
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	3/2 per lb.	
Ferro Tungsten	2/11 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£24 0 0	7/6
,, ,, 6 p.c. to 8 p.c.	£23 0 0	7/-
,, ,, 8 p.c. to 10 p.c.	£23 0 0	6/6
,, ,, Specially refined		
,, ,, Max. 2 p.c. carbon	£34 0 0	12/-
,, ,, ,, 1 p.c. carbon	£38 0 0	15/-
,, ,, ,, 0·70 p.c. carbon	£42 0 0	17/-
,, ,, ,, carbon free	1/2 per lb.	
Metallic Chromium	2/6 per lb.	
FerroManganese (per ton)	£13 15 0 for home; £13 10 0 for export	
,, Silicon, 45 p.c. to 50 p.c.	£12 0 0 scale 5/- per unit	
,, ,, 75 p.c.	£19 10 0 scale 6/- per unit	
,, Vanadium	13/- per lb.	
,, Molybdenum	4/- per lb.	
,, Titanium (carbon free)	1/- per lb.	
Nickel (per ton)	£170 to £175	
Ferro-Cobalt	9/4 per lb.	

FUELS.

SCOTLAND.
(*Prices not stable.*)

	Export.
LANARKSHIRE	
(f.o.b. Glasgow)—Steam	13/-
,, ,, Ell	14/-
,, ,, Splint	15/6 to 16/-
,, ,, Trebles	14/6
,, ,, Doubles	13/6
,, ,, Singles	12/6
AYRSHIRE—	
(f.o.b. Ports)—Steam	13/6
,, ,, Jewel	16/6
,, ,, Trebles	13/9
FIFESHIRE—	
f.o.b. Methil or Burntisland—Steam	12/- to 15/-
Screened Navigation	17/6 to 18/6
Trebles	14/6 to 15/6
Doubles	13/6 to 14/-
Singles	12/-
LOTHIANS—	
(f.o.b. Leith)—Best Steam	13/-
Secondary Steam	12/6
Trebles	14/6
Doubles	13/6
Singles	12/3

ENGLAND.

	Inland.	Export.
(8) N.W. COAST—		
Steams		24/- to 25/-
Household		38/- to 51/-
Coke		25/- to 26/6
NORTHUMBERLAND—		
Best Steams		14/6 to 15/-
Second Steams		13/9 to 14/-
Steam Smalls		9/6 to 10/6
Unscreened		13/- to 13/6
Household		21/- to 26/-
DURHAM—		
Best Gas		16/6 to 16/9
Second		16/- to 16/6
Household		21/- to 27/-
Foundry Coke		22/- to 28/
SHEFFIELD—		
Best Hand-picked Branch	25/6 to 26/6	—
Derbyshire Best Bright House	19/- to 21/-	—
Best House Coal	19/6 to 20/6	—
Screened House Coal	17/6 to 18/6	—
,, ,, Nuts	15/6 to 16/6	—
Yorkshire Hards	15/- to 16/-	—
Derbyshire Hards	15/- to 16/-	—
Rough Slacks	9/- to 10/-	—
Nutty Slacks	7/- to 8/-	—
Smalls	3/- to 5/-	—
Blast-furnace Coke (Inland)	14/6 at ovens	—
Furnace and Foundry Coke (Export), f.o.b.		20/- to 21/-

(9) SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Smokeless Large	19/9 to 20/-
Second Smokeless Large	19/6 to 19/9
Best Dry Large	18/9 to 19/-
Ordinary Dry Large	18/- to 18/6
Best Black Vein Large	18/3 to 18/6
Western Valley Large	18/- to 18/3
Best Eastern Valley Large	17/9 to 18/-
Ordinary Eastern Valley Large	17/3 to 17/9
Best Steam Smalls	13/9 to 14/3
Ordinary Smalls	12/6 to 13/-
Washed Nuts	20/- to 23/6
No. 3 Rhondda Large	20/- to 21/-
,, ,, Smalls	15/6 to 16/-
No. 2 ,, Large	17/- to 17/6
,, ,, Through	15/6 to 16/6
,, ,, Smalls	13/6 to 14/-
Foundry Coke (Export)	26/6 to 36/6
Furnace Coke (Export)	21/- to 23/-
Patent Fuel	20/- to 21/6
Pitwood (ex ship)	30/- to 30/6
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	33/- to 36/6
Seconds	27/6 to 30/-
Red Vein	23/- to 27/-
Machine-made Cobbles	40/- to 44/-
Nuts	40/- to 44/-
Beans	23/6 to 25/6
Peas	18/- to 19/-
Breaker Duff	9/- to 9/6
Rubbly Culm	10/3 to 10/9
Steam Coals:	
Large	18/- to 19/-
Seconds	17/- to 18/-
Smalls	11/3 to 13/-
Cargo Through	15/6 to 16/6

(1) Delivered. (2) Net Makers' Works. (3) f.o.t. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate: Joists (minimum) 12/6, Ordinary Ship, Bridge and Tank Plates and Sections 10/- if home consumers confine purchases from associated British Steel Makers.

French Engineering Notes.

(From our Correspondent in Paris.)

Reparations.

MANUFACTURERS have little that is good to say of the importation of so much material from Germany on account of reparations, but except in some cases, notably rolling stock, they have benefited from that importation to an appreciable extent, in the sense that a considerable volume of work would not have been distributed if it were not for the facilities offered to the State for acquiring a similar quantity of reparation material from Germany. The Government gave an undertaking that orders placed with German firms would be accompanied by orders of equal value to home makers, and in a general way it has kept to the agreement, although now that there is a probability of the Dawes scheme being replaced by the Young proposal, under which the supply of goods on account of reparations will be largely reduced, the State seems inclined to keep as much of the reparation material as possible to itself. The State Railways have ordered rolling stock from Germany to the value of 120 million francs, and it is understood that other heavy consignments are contemplated. The Government has refused permission to other railway companies to procure locomotives and wagons from the same source, so that the opposition of home wagon builders to the importation of German rolling stock may be alleviated by the distribution amongst them of a large quantity of material. The railway companies are preparing to place considerable orders during the next few weeks. At the same time, while the Dawes arrangement may cease to operate at an early date, there is an obvious effort to secure as much reparation material as possible before the Young agreement comes into force. The arrangement has been a remarkably good one for France. Without it, scarcely any of the great public works could have been put in hand, and the enterprises already completed in the way of hydro-electric plants, harbour equipments and port extensions, inland waterways and railways, have increased enormously the country's economic value. Notwithstanding the objections of manufacturers, they have not suffered from this German participation in the French economic development, for the work could not have been carried out without the German aid, and the activity created by the programme has helped practically every branch of industry. The situation has rarely been so good as during the past year. In a general way, the production is only limited by the labour supply, and the shortage of skilled hands is compelling manufacturers to improve their methods and adopt machinery wherever possible, with the result that there is usually plenty of work for machinery makers.

Rail and Road Transport.

The railway companies have been steadily developing their programme of associating road traction with rail transport. Last year they created auxiliary companies which would control the road services where they were in direct connection with the railways. These companies could establish independent lines of motor cars or absorb private services or else collaborate with them. While the other railway companies have, so far, confined themselves chiefly to the organisation of tourist services, the State Railways have covered a much wider field, and in Normandy and Brittany they are now running cross-country services to connect up their system, and are working in association with local bodies for carrying passengers to places of interest in the neighbourhood. A still more ambitious scheme is the running of powerful and luxurious cars between Paris and the ports, so that passengers on landing can have their luggage sent on by train while they themselves will travel by road, with stoppages at points of interest on the way, and will be conveyed directly to their hotels. It is stated that the first service will be run between Paris and Cherbourg at an early date. The policy of the railway companies is to control and develop all kinds of transport, and it is proposed to replace railway tickets with kilometre tickets, from which will be detached the number of coupons required to travel stated distances by rail, car or aeroplane.

Canalising the Rhone.

Two events have awakened renewed interest in the scheme for canalising the Rhone, one being the visit of the technical commission, together with the Minister of Public Works, to the Rhone Valley, and the other the holding of the third Congress at Geneva to discuss questions concerning continuous navigation on the Rhone, Rhine and Danube. The idea is to create a great inland waterway which will connect up Marseilles with central and eastern Europe. So far as the Rhone is concerned, it is hoped to construct sixteen barrages with power stations providing 5,000,000 kWh a year, to afford navigation for 1200-ton boats between the Etang de Berre and Switzerland, and to irrigate about 650,000 acres of agricultural land. The proposal to canalise the river itself seems to be losing ground, and there is a growing preference for a lateral canal, which will overcome the technical difficulties of dealing with a rapid current and will allow of loads of 5 tons per horse-power being hauled towards Switzerland instead of only 1 ton against the current of the river. The rival schemes continue to be discussed, and all are criticised by certain economists, who declare that the scheme for converting the Etang de Berre into a vast port which would divert traffic between Central Europe and the East is not conceived on sound lines, because the proposed canal can offer no special advantage over the existing means of international transport.

The Makhonine Fuel.

Some years ago a great deal of prominence was given to the invention of Monsieur Makhonine, a Russia engineer, for producing petrol direct from heavy oils in an apparatus fitted in the place of the carburetter. Then he invented a "national fuel" from coal tar, and for the past two or three years there has been occasional controversy on the supposed value of this discovery. The Air Ministry has carried out numerous tests, and an official report has now been issued, from which it appears that the Makhonine fuel is less satisfactory than petrol and offers no advantage from the point of view of security.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

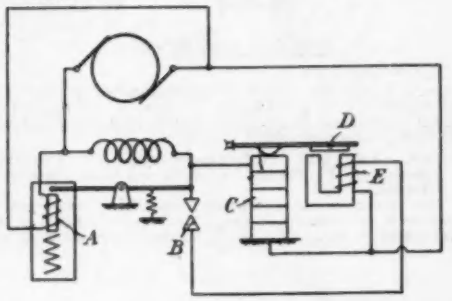
The date first given is the date of application; the second date at the end of the abridgment, is the date of the acceptance of the complete Specification.

DYNAMOS AND MOTORS.

292,521. June 20th, 1928.—REGULATOR FOR KEEPING THE CURRENT OR VOLTAGE OF GENERATORS CONSTANT, Brown, Boveri et Cie, of Baden, Switzerland.

This specification describes a quick-acting regulator for keeping the current or voltage of a generator constant. The regulator A is provided with a trembler coil, and at B there are vibrating contacts in the exciter circuit. A carbon compression regulator C is connected in parallel with the vibrating contacts. The resistance of this regulator is regulated by the pressure of the armature D, which is acted upon by the electro-magnet

Nº292,521

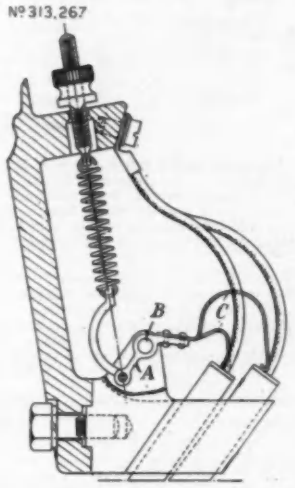


E. In the event of the whole of the exciter current flowing through the vibrating contacts, the electro-magnet will be strongly excited, and the armature D will exert a strong pressure on the carbon regulator, the resistance of which will be reduced and the voltage of the generator will rise. The vibrating regulator will, however, put in resistance between the contacts B which will result in the pressure on the carbon pile being reduced. This cycle of operations is repeated automatically, and the voltage of the generator is maintained constant.—*June 13th*, 1929.

313,267. April 30th, 1928.—BRUSH HOLDERS FOR DYNAMO-ELECTRIC MACHINES, Gustaf Adolf Juhlin, of Redcar, Moss-lane, Timperley, Chester; Robert Townend, of 17, Meadown-bank, Chorlton-cum-Hardy, Manchester, and Associated Electrical Industries, Ltd., of Bush House, Aldwych, London.

A brush holder constructed in accordance with this inven-

Nº313,267



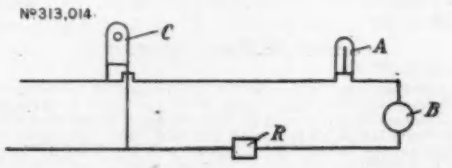
tion is provided with a bell crank lever A, pivoted at B. One arm of the lever is provided with resilient extensions C, which bear on the brush in the manner shown, whilst the other end is connected to an adjustable tension spring connected to a fixed support. The advantages claimed for the holder are easy manipulation and simple manufacture.—*June 13th*, 1929.

MEASURING AND TESTING INSTRUMENTS.

313,014. December 1st, 1927.—INSTRUMENT FOR INDICATING AND/OR RECORDING ELECTRICAL PRESSURES, CURRENTS, OR RESISTANCES, John Neale, of 15, Acacia-road, St. John's Wood, London, N.W. 8.

A light sensitive bridge A is connected in series with a record-

Nº313,014

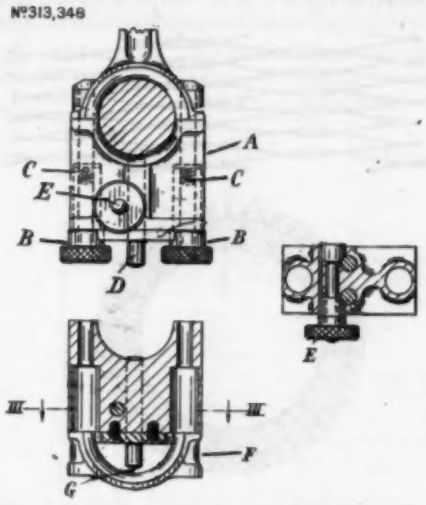


ing or indicating instrument B in parallel with an electric lamp C. A drop in voltage of the supply mains is followed by a drop in the current flowing through the lamp and bridge. This results in a decrease in the illumination of the lamp, and consequently an increase in the resistance of the light sensitive bridge. This, in turn, leads to a further decrease in current in the bridge circuit, which is therefore subjected to a double action, owing to a single drop in the value of the main supply circuit. It is therefore possible to obtain much greater sensitiveness than usual. The resistance R is provided for rough adjustment, but fine adjustment is obtained by moving the lamp by means of a rack and pinion towards or away from the bridge.—*June 4th*, 1929.

313,348. July 14th, 1928.—APPARATUS FOR INDICATING WEAR OF DIVIDED BEARINGS, The Daimler Company, Ltd., and L. H. Pomeroy, Sandy-lane, Coventry.

This device is intended primarily for facilitating the rebedding of worn big-end bearings. The cap of the bearing is taken off and is replaced by the jig A, which is held in place by the nuts

Nº313,348



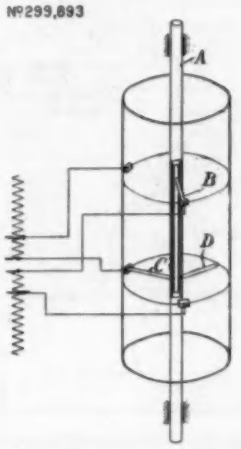
B B being screwed on to the studs C C. The plunger D—or, it may be, two parallel plungers—is then pushed in to meet the crank pin and is locked in place by the bolt E. The bearing cap F is then placed against the jig and the clearance G, between the end of the plunger D, and the bearing face of the cap indicates any wear which may have taken place.—*June 13th*, 1929.

TRANSFORMERS AND CONVERTERS.

299,893. November 2nd, 1928.—SWITCHES FOR USE WITH TRANSFORMERS, *International General Electric Company, Incorporated, of* 120, *Broadway, New York.*

As shown in the drawing, the transformer winding is divided into two equal portions, and the switch shown on the right of the drawing is arranged so that three different voltages can be

Nº299,893



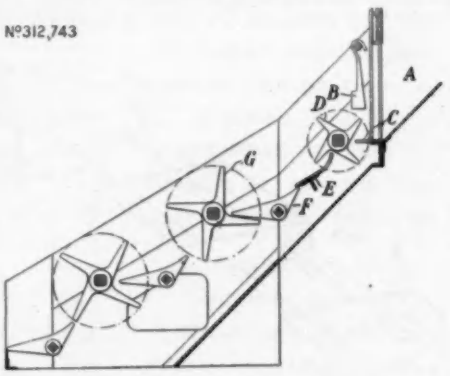
obtained. The two portions of the winding are tapped, and the tapping points are connected to stationary contacts on the switch, as shown. The movable part of the switch comprises a spindle A carrying arms B C D, which are electrically connected. It will readily be seen that by revolving the spindle A the ratio of the transformer can be altered.—*June 13th*, 1929.

MINING MACHINERY.

312,743. March 26th, 1928.—SCREENS, Woodhall-Duckham (1920), Ltd.; and S. Symington, 136, Victoria-street, London, S.W. 1.

This screen is intended for coke, coal, and other more or less

Nº312,743



friable materials. The coke, for instance, is fed down the shoot A past the freely suspended baffles B on to the comb C. It is picked up from this comb by the star wheel D, which rotates anti-clockwise, and passed on to the plate E. From this plate it slides on to the grizzly F, between the bars of which there

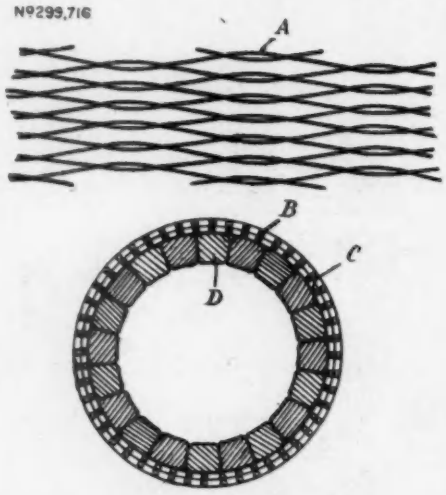
works another star wheel G, and so on as far as may be necessary. The first star wheel is driven at a slower speed than the others.—*June 6th*, 1929.

TRANSMISSION OF POWER.

299,716. October 29th, 1928.—ELECTRIC CONDUCTORS, *International General Electric Company, Incorporated, of 120, Broadway, New York.*

This specification describes a hollow conductor for the transmission of current at high voltages. The object of the invention is to avoid excessive losses owing to corona and skin effects.

Nº299,716



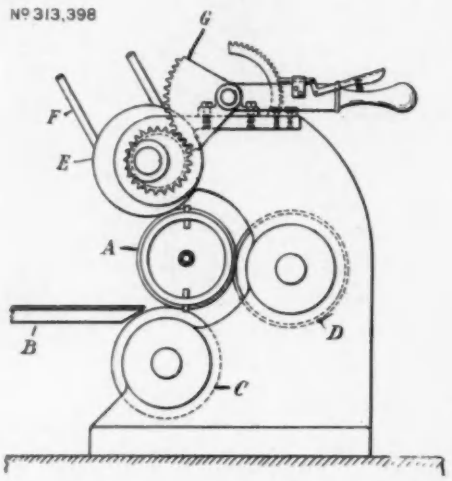
The individual wires A are plaited, as shown in the upper drawing. These plaited conductors may be arranged in layers as shown in section at B and C, and, according to one scheme, they may be supported on solid conductors D, which are pressed together and held by the plaited fabric outside. A cable built in this way is said to be free from tension and twist, and the scheme leads to economy in manufacture.—*June 13th*, 1929.

MACHINE TOOLS AND SHOP APPLIANCES.

313,398. December 3rd, 1928.—CENTRIFUGAL CASTING MACHINES, *R. Haddan*, 31, *Bedford-street, Strand, London, W.C. 2.*

This invention is concerned with the centrifugal casting of pipes, and aims at the expedition of the insertion and removal of the moulds from the spinning machine. The mould A is

Nº313,398



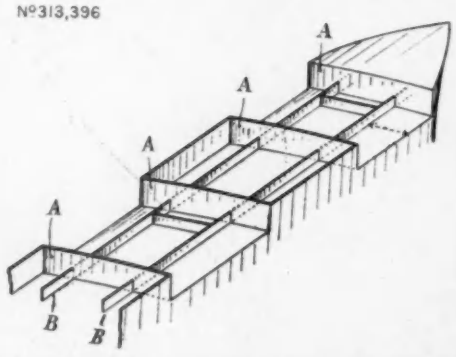
rolled into position across a table B and is supported by two rolls C and D in such a position that little effort is necessary to draw it out again. The mould is rotated by the frictional engagement of the roll E, which is driven by belt, as indicated at F. This roll is mounted in excentric bearings and can be pressed down on to the mould by means of the quadrant gear shown at G.—*June 13th*, 1929.

SHIPS AND BOATS.

313,396. November 5th, 1928.—SHIPS' HULLS, D. Smith, 21, Gabelsgate, Oslo, Norway.

The inventor argues that the support of the deck of a vessel by means of beams beneath that deck reduces the cargo space available in the holds. As a consequence, he supports the deck

Nº313,396



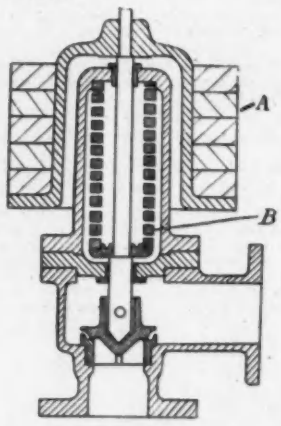
by means of continuous fore and aft coamings alongside the hatchways, and reinforces these coamings by "bulkheads" above deck. In the drawing these bulkheads are indicated at A A, and the continuous coamings at B B.—*June 13th*, 1929.

MISCELLANEOUS.

312,881. September 17th, 1928.—SAFETY VALVES, L. F. Norrie, 30, South Fort-street, Bonnington, Edinburgh.

This safety valve is loaded conjointly by a deadweight A and

Nº312,881

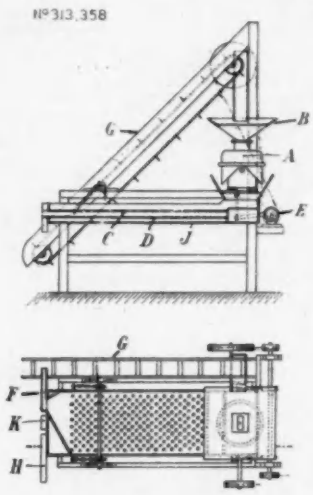


a spring B, but why such an arrangement should be adopted is not disclosed in the specification. It is advised that the loading on the valve should be shared equally between the weight and the spring.—*June 6th*, 1929.

313,358. July 30th, 1928.—CENTRIFUGAL NUT CRACKING MACHINES, B. Branda, 4, Boulevard Pons, Marseille, France.

This "invention" is virtually an adaptation of stone-breaking practice to the cracking of nuts. The nuts are cracked in the centrifugal machine A, of which no details are given in the

Nº313,358

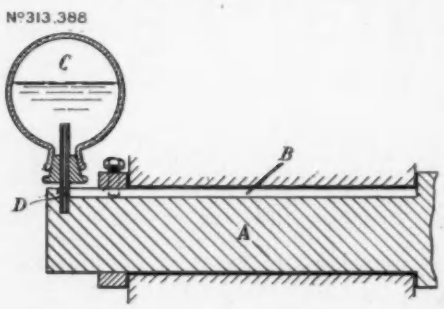


specification, being fed in through the hopper B. The broken product is delivered on to the perforated trays C and D, which are jigged by the excentric gear E. Nuts which are insufficiently broken go by the shoot F and elevator G back to the hopper B. Properly broken stuff is taken away by the shoot H to be bagged, and *débris* falling on to the tray J is discharged at K.—*June 13th*, 1929.

313,388. October 6th, 1928.—LUBRICATORS, J. Wych, Norhyde, Rossal-road, Cleveleys, Lancs., and Ashton Brothers and Co., Ltd., 29, Portland-street, Manchester.

This invention is concerned with the lubrication of such journals as those in which a wheel rotates about a fixed peg or shaft. The peg A is provided with an oil groove B, along its

Nº313,388



upper face, and towards the outer end there is arranged the oil bottle C. In the outlet pipe of this bottle there is a fine hole D made at such a level that if the oil in the groove is depleted, the hole is uncovered, a few bubbles of air are admitted to the bottle, and sufficient oil is discharged to replenish the groove.—*June 13th*, 1929.

THE INSTITUTE OF TRANSPORT.—Examinations for Graduateship and Associate Membership of the Institute of Transport will be held in London and at other centres on Thursday, Friday and Saturday, April 24th, 25th and 26th, 1930. The main line railways, the Metropolitan Railway, and the London Underground Railways, and L.G.O.C. group, subject to the exigencies of each company's business, have agreed to grant leave of absence (without loss of pay) to members of their staffs taking these examinations. Fuller particulars, forms of application, and copies of the complete syllabuses (price to non-members 1s. post free), and of the papers set at previous examinations (price 1s. per set post free) can be obtained from the secretary, the Institute of Transport, 15, Savoy-street, London, W.C. 2.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY TO SATURDAY, JULY 27TH.

AIRCRAFT EXHIBITION.—Olympia. Seventh International Aircraft Exhibition.

TUESDAY TO THURSDAY, JULY 23RD TO 25TH.

NEWCOMEN SOCIETY.—Summer meeting at Dartmouth, Devon. For programme see page 25.

TUESDAY, JULY 30TH.

CRYSTAL PALACE SCHOOL OF PRACTICAL ENGINEERING.—One hundred and seventieth award of certificates. 3 p.m.

SATURDAY TO TUESDAY, AUGUST 3RD TO 13TH.

INSTITUTION OF ELECTRICAL ENGINEERS: LONDON STUDENTS' SECTION.—Summer Tour, 1929. The tour will be held this year in Paris and Northern France.

TUESDAY TO FRIDAY, SEPTEMBER 10TH TO 13TH.

IRON AND STEEL INSTITUTE.—Autumn meeting at Newcastle-on-Tyne.

THURSDAY TO SATURDAY, SEPTEMBER 12TH TO 28TH.

SHIPPING, ENGINEERING AND MACHINERY EXHIBITION, Olympia.

SATURDAY TO SATURDAY, SEPTEMBER 14TH TO 28TH

INSTITUTION OF NAVAL ARCHITECTS.—Summer meeting in Italy. For programme see page 380, April 5th, 1929.

LAUNCHES AND TRIAL TRIPS.

THURLAND CASTLE, twin-screw motor vessel; built by Cammell Laird and Co., Ltd., to the order of Lancashire Shipping Company, Ltd. Engines constructed by North-Eastern Marine Engineering Company, Ltd.; trial trip, recently.

TRENTBANK, steamship; built by Workman Clark (1928), Ltd., to the order of Messrs. Andrew Weir and Co.; dimensions, 436ft. by 56ft. by 36ft. 3in.; to carry cargo. Engines, quadruple-expansion, 22in., 32in., 46½in., 68in. by 48in. stroke, pressure 260 lb. per square inch; constructed by the builders; launch, June 20th.

HENRY STANLEY, single-screw motor vessel; built by Ardrossan Dockyard, Ltd., to the order of the African Steamship Company; dimensions, 370ft. by 51ft. 6in. by 33ft. 6in.; launch, June 21st.

SAINT CLAIR, two-deck steamer; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of Société Française d'Armement, of Marseilles; 6200 tons. Engines, on the Bauer-Wach system; constructed by the builders; launch, June 26th,

GOSCHEN, twin-screw steamer; built by D. and W. Henderson and Co., Ltd., to the order of the South Indian Railway Company; dimensions, 250ft. by 38ft. by 12ft.; to carry passengers and cargo. Engines, two geared turbines and water-tube boilers; constructed by Yarrow and Co., Ltd.; launch, June 27th.

BARON VERNON, steel screw cargo steamer; built by D. and W. Henderson and Co., Ltd., to the order of H. Hogarth and Sons, Ltd., Glasgow; dimensions, 350ft. by 50ft. by 25ft. 9in.; to carry cargo. Engines, triple-expansion, 21½in., 37in., 62in. by 42in. stroke, pressure 210 lb. per square inch; constructed by the builders; trial trip, June 29th.

GODFREY B. HOLT, cargo vessel; built by Cammell Laird and Co., Ltd., to the order of J. Holt and Co. (Liverpool), Ltd.; dimensions, 330ft. by 47ft. by 28ft.; to carry cargo; constructed by the builders; trial trip, recently.

BEAUFORT, steam-driven tanker; built by Barclay, Curle and Co., Ltd., to the order of Messrs. Biarn Biarnstad and Co., Oslo, Norway; dimensions, 400ft. by 52ft. 6in. by 30ft. 6in.; to carry oil in bulk. Engines, triple-expansion, 25in., 42in., 71in. by 48in. stroke; launch, July 4th.

LLANGIBBY CASTLE, motor vessel; built by Harland and Wolff, Ltd., to the order of the Union-Castle Mail Steamship Co., Ltd.; dimensions, 485ft. by 66ft. by 33ft. 6in.; to carry passengers and cargo. Engines, two sets of single-acting Diesel units on the Harland—B. and W. system; constructed by the builders; launch, July 4th.

SIR JOHN HAWKINS, twin-screw passenger steamer; built by Earle's Shipbuilding and Engineering Company, Ltd., to the order of Great Western Railway Company; dimensions, 180ft. by 43ft. 2in. by 15ft. 9in.; to carry passengers and mails from liners from Plymouth and the Lizard. Engines, triple-expansion, 16½in. by 27in. by 46in. by 30in. stroke, pressure 185 lb. per square inch; constructed by the builders; trial trip, July 4th.

LANGLEETARN, steel-screw steamer; built by Palmer's Shipbuilding and Iron Company, Ltd., to the order of Medomsley Steam Shipping Company, Ltd.; 9000 tons. Engines, triple-expansion; constructed by North-Eastern Marine Engineering Company, Ltd.; launch, July 5th.

CARBROOK, steamship; built by Cowpen Dry Docks and Shipbuilding Company, Ltd., to the order of Cory Colliers, Ltd. dimensions, 265ft. by 37ft. 6in. by 19ft.; to carry 2500 tons on a draught of 17ft. 4in. Engines, triple-expansion, 19in., 31in., 52in. by 36in. stroke; constructed by Geo. Clark, Ltd., of Sunderland; launch, July 6th.

NEW WESTMINSTER CITY, steamship; built by Wm. Gray and Co., Ltd., to the order of Sir William Reardon Smith and Sons, Ltd., Cardiff; dimensions, 400ft. by 54ft. 3in. by 28ft. 0½in.; to carry cargo. Engines, triple-expansion, 25in., 42in., 70in. by 48in. stroke, pressure 200 lb. per square inch; constructed by Central Marine Engine Works of the builders; trial trip, July 6th.

VIKINGEN, twin-screw steamer; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of Viking Whaling Company, Ltd.; dimensions, 490ft. by 71ft.; to carry on as a whaling factory. Engines, two sets triple-expansion; constructed by the builders; launch, July 6th.

BARAO DE MAUA, barge loading bucket dredger; built by Wm. Simons and Co., Ltd., Renfrew, to the order of the Government of the State of Pernambuco, Brazil. Engines, triple-expansion, pressure 160 lb. per square inch; constructed by the builders; launch, July 8th.

EL AMIRA FAWZIA, twin-screw steamer; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of Coastguards and Fisheries Administration of the Egyptian Government; dimensions, 286ft. by 38ft.; to carry passengers and cargo. Engines, triple-expansion, pressure 180 lb. per square inch; constructed by Yarrow and Co., Ltd.; launch, July 8th.